U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1872

Retention of Selected FBCB2 Operating Skills among Infantry Captains Career Course (ICCC) Students

Gregory A. Goodwin
U.S. Army Research Institute

Bruce C. Leibrecht, Richard L. Wampler, Stephen C. Livingston
Northrop Grumman Technical Services

Jean L. Dyer
U.S. Army Research Institute

July 2007

Approved for public release; distribution is unlimited.

20070816064

U.S. Army Research Institute for the Behavioral and Social Sciences

A Directorate of the Department of the Army Deputy Chief of Staff, G-1

Authorized and approved for distribution:

PAUL A. GADE
ACTING TECHNICAL DIRECTOR

MICHELLE SAMS, Ph.D.
DIRECTOR

Research accomplished under contract for the Department of the Army

Northrop Grumman Technical Services

Technical review by

Brooke B. Schaab, U.S. Army Research Institute
John S. Barnett, U.S. Army Research Institute

NOTICES

DISTRIBUTION: Primary distribution of this Research Report has been made by ARI. Please address correspondence concerning distribution of reports to: U.S. Army Research Institute for the Behavioral and Social Sciences, Attn: DAPE-ARI-MS, 2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926

FINAL DISPOSITION: This Research Report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this Research Report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
July 2007	Final	August 2005 to December 2006

4. TITLE AND SUBTITLE	
Retention of Selected FBCB2 Operating Skills among Infantry Captains Career Course (ICCC) Students	5a. CONTRACT OR GRANT NUMBER W74V8H-04-D-0045 (DO #08)
	5b. PROGRAM ELEMENT NUMBER 622785
6. AUTHOR(S) Gregory A. Goodwin (U.S. Army Research Institute) Bruce C. Leibrecht, Richard L. Wampler, and Stephen C. Livingston (Northrop Grumman Technical Services) Jean L. Dyer (U.S. Army Research Institute)	5c. PROJECT NUMBER A790
	5d. TASK NUMBER 326
	5e. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Northrop Grumman Technical Services 3565 Macon Road Columbus, GA 31907 U.S. Army Research Institute for the Behavioral and Social Sciences Infantry Forces Research Unit PO Box 52086 Fort Benning, GA 31995-2086	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U. S. Army Research Institute for the Behavioral & Social Sciences ATTN: DAPE-ARI-IJ 2511 Jefferson Davis Highway Arlington, VA 22202-3926	10. MONITOR ACRONYM ARI
	11. MONITOR REPORT NUMBER Research Report 1872

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Contracting Officer's Representative: Jean L. Dyer Subject Matter POC: Gregory A. Goodwin

14. ABSTRACT *(Maximum 200 words)*:

This report describes an investigation of the retention of Force XXI Battle Command Brigade and Below (FBCB2) operator knowledge and skills. Infantry captains who attended a two-day training course participated in an end-of-course test followed by a retest eight weeks later. Participants answered questions about and performed tasks on FBCB2. Performance on the knowledge test showed no decay while performance on the hands-on test declined slightly (10%), but significantly. The majority of participants (72%) had used FBCB2 in combat. Interestingly, the best single predictor of performance on the hands-on test was a self-reported measure of general computer experience. In general, though, it was difficult to predict performance on the hands-on test. Multiple regression analyses using a variety of experience and knowledge measures accounted for only 25-30% of the variability in recall scores. Implications of these findings for trainers, training developers, and Army units are discussed.

15. SUBJECT TERMS

Digital Training FBCB2 Operator Skills Skill Retention Knowledge Retention Digital Proficiency Training Methodology Performance Measurement

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON
16. REPORT Unclassified	17. ABSTRACT Unclassified	18. THIS PAGE Unclassified	Unlimited		Ellen Kinzer, Technical Publication Specialist 703.602.8047

Research Report 1872

Retention of Selected FBCB2 Operating Skills among Infantry Captains Career Course (ICCC) Students

Gregory A. Goodwin
U.S. Army Research Institute

Bruce C. Leibrecht, Richard L. Wampler, Stephen C. Livingston
Northrop Grumman Technical Services

Jean L. Dyer
U.S. Army Research Institute

Infantry Forces Research Unit
Scott E. Graham, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
2511 Jefferson Davis Highway, Arlington, Virginia 22202-3926

July 2007

Army Project Number
622785A790

Personnel Performance
and Training Technology

Approved for public release; distribution is unlimited.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the digital instructors in the Directorate of Operations and Training at Fort Benning, Georgia. Our data collection effort would not have been possible without the cooperation of Alfredo Lezcano, Scott Hardcastle, Todd Fancher, Louis Leavell, and Nelson Baldwin. They all contributed to this project in different ways, from reviewing the test materials to supporting data collection. Of all of these instructors, Al Lezcano deserves special mention. He served as our primary point of contact with the instructors and generously contributed many hours of his time helping to improve our metrics, refine our testing procedures, and answer our questions about digital training. We cannot thank him enough for his expertise and help. Additionally we would like to thank Christopher Strauss and Andy Perrault of Northrop Grumman Corporation for their help in developing the evaluation materials, as well as Mike Dlubac and Amy Batiz for supporting the collection of data.

RETENTION OF SELECTED FBCB2 OPERATING SKILLS AMONG INFANTRY CAPTAINS CAREER COURSE (ICCC) STUDENTS

EXECUTIVE SUMMARY

Research Requirement:

The U.S. Army Research Institute's Infantry Forces Research Unit supports Army transformation by conducting research on innovative methods for training Soldiers and leaders. Much of the research focuses on building and sustaining proficiency among digitally equipped forces. Sustaining digital proficiency requires informed decisions about allocating limited training resources and time. Given the widespread use of digital systems, a better understanding of the decay of digital skills is needed for training programs in institutions and operational units. The current research was designed to examine the decay of skills and knowledge following familiarization training on the Force XXI Battle Command Brigade and Below (FBCB2).

Procedure:

The research team administered tests of FBCB2 system knowledge and hands-on skills to 54 career course captains at Fort Benning, Georgia. The baseline test immediately followed a two-day FBCB2 familiarization course. The retest occurred eight weeks later. Data were analyzed to characterize the level of mastery and subsequent decay for FBCB2 knowledge and skills parameters. The analysis also examined task dimensions and participant variables that influenced proficiency and retention.

Findings:

Overall scores on the hands-on test (72% at baseline) exceeded those on the knowledge test (40% correct at baseline). Performance on the hands-on test declined modestly (10%) after eight weeks whereas knowledge recall was decay-resistant. Although overall decay on the hands-on test was small, greater decay was observed for individual tasks. Significant decay was observed for three of the thirteen hands-on tasks with declines ranging from 19% to 24%. Participant characteristics (such as self-rated FBCB2 proficiency) related to basic performance parameters as well as retention measures. Multiple regression analysis factoring in a variety of experience and training measures accounted for 25-32% of the variability in hands-on test scores. An examination of the specific errors made suggest that inadequate memory cues and inattention to system details contributed to skill decay.

Utilization and Dissemination of Findings:

The findings and recommendations from this research represent the first empirical measurements of FBCB2 skill decay. Although a limited number of skills was observed, this effort was important because it demonstrated the utility of the data collection techniques and identified a number of potential causes for skill decay on this system. The findings can benefit FBCB2 trainers and unit leaders who work to ensure Soldier proficiency with digital skills.

Findings could assist human factors specialists supporting system design. In conjunction with a related digital research effort, these findings were briefed to the TRADOC Capabilities Manager Stryker-Bradley office at Fort Benning, Georgia.

RETENTION OF SELECTED FBCB2 OPERATING SKILLS AMONG INFANTRY CAPTAINS CAREER COURSE (ICCC) STUDENTS

CONTENTS

Page

INTRODUCTION 1

METHOD 3
Participants 3
Measurement Instruments 4
Procedure 7

RESULTS 8
Experience and Training 8
Knowledge Test Performance and Retention 11
Hands-on Test Performance and Retention 14
Common Errors on the Recall Test 18
Time to Complete Hands-on Tasks 21
Use of FBCB2's Help Function 22
Predictors of Knowledge and Hands-on Test Scores 23

DISCUSSION 27
Retention of Digital Operating Skills 27
Predictors of Test Performance 30
Techniques for Counteracting Decay 32
Lessons Learned 33
Conclusions 34

REFERENCES 37

APPENDIX A. ACRONYMS A-1

APPENDIX B. KNOWLEDGE AND HANDS-ON MEASUREMENT INSTRUMENTS B-1

APPENDIX C. SCORING MATERIALS FOR KNOWLEDGE AND HANDS-ON TESTS .C-1

APPENDIX D. STATISTICAL TABLES FOR ITEM ANALYSES D-1

APPENDIX E. STEPS FOR COMPLETING HANDS-ON TASKS E-1

LIST OF TABLES

TABLE 1. PERCENT (%) OF PARTICIPANTS IN VARIOUS DUTY POSITIONS DURING COMBAT TOURS 3

TABLE 2. MEAN SCORES OF THOSE WHO ATTENDED THE BASELINE SESSION ONLY VERSUS THOSE WHO ATTENDED BOTH SESSIONS 4

TABLE 3. PERCENT (%) OF PARTICIPANTS WHO RECEIVED INDIVIDUAL TRAINING ON DIGITAL SYSTEMS....8

TABLE 4. PERCENT (%) OF PARTICIPANTS WHO RECEIVED COLLECTIVE UNIT TRAINING ON DIGITAL SYSTEMS....9

TABLE 5. COMBAT USE OF DIGITAL SYSTEMS REPORTED BY PARTICIPANTS 9

TABLE 6. SELF-RATINGS OF OPERATOR ABILITY (% OF PARTICIPANTS) 9

TABLE 7. GENERAL COMPUTER EXPERIENCE (% OF PARTICIPANTS) 10

TABLE 8. CORRELATIONS AMONG MEASURES OF EXPERIENCE AND TRAINING .10

TABLE 9. CORRELATIONS AMONG KNOWLEDGE TEST SCORES....11

TABLE 10. PERCENT (%) OF THE SAMPLE ANSWERING EACH QUESTION CORRECTLY ON THE KNOWLEDGE TEST....12

TABLE 11. PERCENT (%) OF THE SAMPLE ANSWERING EACH COMPONENT CORRECTLY ON THE KNOWLEDGE TEST....13

TABLE 12. CORRELATIONS AMONG HANDS-ON TEST SCORES....15

TABLE 13. PERCENT (%) OF THE SAMPLE CORRECTLY PERFORMING THE 13 HANDS-ON TASKS 16

TABLE 14. PERCENT (%) OF THE SAMPLE CORRECTLY COMPLETING COMPONENTS OF EACH HANDS-ON TASK....17

TABLE 15. RATES FOR TYPES OF ERRORS MADE ON THE HANDS-ON RECALL TEST 19

TABLE 16. MEAN TIME SPENT PER TASK IN HANDS-ON TESTS (BASELINE AND RECALL) 21

TABLE 17. SELF-REPORTED USAGE OF SYSTEM HELP IN RETEST BY TASK 23

TABLE 18. CORRELATIONS BETWEEN TRAINING AND EXPERIENCE AND KNOWLEDGE AND HANDS-ON TEST MEASURES....23

TABLE 19. CORRELATIONS BETWEEN KNOWLEDGE AND HANDS-ON TEST SCORES 24

TABLE 20. MULTIPLE REGRESSION COEFFICIENTS (R) FOR BASELINE AND RECALL HANDS-ON TEST RESULTS 25

LIST OF FIGURES

FIGURE 1. MEAN SCORES ON THE HANDS-ON BASELINE AND RECALL TESTS 15

FIGURE 2. MEAN SCORES ON THE KNOWLEDGE AND HANDS-ON TESTS BY SELF-RATED PROFICIENCY LEVEL 26

Retention of Selected FBCB2 Operating Skills among Infantry Captains Career Course (ICCC) Students

Introduction

The Army Battle Command System (ABCS) is a computerized command and control (C3) system. The ABCS family includes the All Source Analysis System (ASAS) used by the intelligence staff; the Advanced Field Artillery Tactical Data System (AFATDS) used by fire support elements; the Force XXI Battle Command Brigade and Below (FBCB2) used in vehicles and command posts for tracking vehicle locations; and the Maneuver Control System (MCS) used by the maneuver staff.

These systems allow leaders to share information including Global Positioning System (GPS) position information on friendly and enemy units, graphics, overlays, reports, and orders, over a tactical digital network. The information comes not only from Soldiers on the battlefield, but from an array of human controlled and unattended sensors. Not only do the digital systems help to distribute information but they can be used to analyze and manage it as well (Seacord, 2000).

In theory, the ABCS is to be a force multiplier, allowing commanders to react faster, deploy forces more efficiently, and ultimately plan and make decisions more rapidly than their adversaries. Unfortunately, the full potential of these systems has not been realized (Clark, 2005). Numerous problems including non-standard hardware, software incompatibilities across different versions of various systems, the need for contractor support to maintain network operability, and training that cannot keep pace with software upgrades have all limited the effectiveness of these systems (Clark, 2005).

In addition to these challenges, Soldiers and leaders have found that their proficiency at operating these systems is perishable if they don't regularly work with them. Much of the evidence for this comes from anecdotal reports by various leaders (e.g., Lynch, 2001) or from analysis of training exercises (e.g., U.S. Army Armor Center, 1996). This belief was also conveyed by leaders who participated in the Army Research Institute project *Managing at the Speed of Change in Force XXI* (Johnston, Leibrecht, Holder, Coffey, & Quinkert, 2002).

These reports of the perishability of digital skills agree with what psychologists have known about discrete procedural skills (a category into which most digital skills fall) since the 1950s, namely that they are easily forgotten relative to continuous skills (Adams, 1987). Discrete procedural skills are differentiated from continuous skills in that the former have a distinct beginning and end. Continuous skills are skills like riding a bike, which, as the proverbial wisdom goes, are rarely forgotten once learned. In an aircraft cockpit, for example, pilots use checklists to avoid forgetting discrete tasks like engine startup or takeoff procedures. Studies have shown that without rehearsal, pilots' memory for such tasks would decay to dangerous levels within a matter of weeks. On the other hand, pilots' memory for maneuvering the aircraft, a continuous skill, shows virtually no decay over long periods of time (Schendel, Shields, & Katz, 1978).

Another type of memory that is resistant to decay is explicit memory. Explicit memory, also called declarative memory, has been shown to last for decades (e.g., Bahrick, 1979). Thus, one expectation of the current research project is that conceptual knowledge, also called semantic memory or common sense knowledge, about a digital system will be more resistant to decay than will knowledge for discrete procedural tasks.

Despite the relatively widespread belief that digital skills are perishable, there is very little experimental evidence documenting either the extent of the decay or the specific tasks that are most likely to be forgotten. In fact, Schaab and Moses (2001) found evidence that for some individuals, there may be little decay. In a cross-sectional examination of enlisted military intelligence personnel who received training on ASAS, these authors found only a small amount of skill decay. Specifically, a group of 21 individuals tested after a two-month retention interval showed 90% proficiency and two individuals scored 78% on a proficiency test taken one year after training. The authors concluded that contrary to common wisdom, the digital skills they observed showed very little decay (Schaab & Moses, 2001).

Larger amounts of skill decay were documented in an experiment performed on the retention of message and overlay tasks using the Inter-Vehicular Information System (IVIS), a vehicle mounted digital system that pre-dated FBCB2 (Sanders, 1999). In this experiment, Soldiers were trained on a series of report and overlay tasks. Overlay skills involved creating and sending a graphical map overlay and report skills involved sending text messages. At the conclusion of training, participants completed four overlay and three report tasks. Those completing three overlay tasks successfully were considered overlay skilled and those completing two report tasks were considered report skilled. Following a 30 day interval with no training, participants were again given four overlay and three report tasks. The researchers found a significant (52%) reduction in the number of overlay skilled Soldiers and a significant (23%) reduction in the number of report skilled Soldiers.

To date, no experimental data have documented the rate of forgetting of tasks on the current ABCS suite of systems. Knowledge of the rates at which various tasks are forgotten on ABCS systems is needed by training developers and operational Army units. Training developers need this information to tailor training techniques and develop memory aids to improve the retention of the most perishable tasks. Unit leadership needs this information to budget training time more efficiently by focusing on the tasks that most need refreshing.

To begin to fill this gap in our knowledge of the decay rates of digital tasks, researchers assessed FBCB2 proficiency in a group of officers attending the Infantry Captains Career Course (ICCC) at Fort Benning, Georgia. The ICCC officers completed a knowledge test and a hands-on proficiency test immediately following an FBCB2 training session then repeated both tests after an eight week period with no FBCB2 practice.

This research aimed to initiate an empirical basis for determining factors that impact the retention of digital operating skills. The investigation focused on the institutional training environment found in schoolhouses and installation learning centers. The specific research objectives included developing and testing a method for characterizing proficiency of FBCB2 knowledge and skills and capturing lessons learned to help improve retention of digital skills.

Method

Participants

Participants were officers attending the ICCC at Fort Benning, Georgia during the spring and summer of 2006. All participants had just completed 16 hours of FBCB2 familiarization training. During the two days of this familiarization training, officers received hands-on training of common FBCB2 functions using a desktop computer.

A total of 77 officers participated in the baseline measurement session and 54 (70%) returned for the recall measurement session. For purposes of simplicity in data analysis, only the data from the group that participated in both measurement sessions were analyzed. An examination of the 23 Captains who were only tested at baseline revealed no distinctive characteristics of this group. For example, of those participating in both the baseline and recall measurements, 80% had experience using at least one digital system in a combat theater compared with 79% for those tested only at baseline. Of those who participated in both measurement sessions, 65% reported combat experience in Iraq compared with 69% of those tested only at baseline. Those only tested at baseline were slightly less likely to have combat experience in Afghanistan (9%) than those who participated in both measurement sessions (15%). Table 1 compares the combat duty positions of the baseline only group to the group that attended both baseline and recall sessions. A chi-square comparison of these two groups found no significant differences across duty positions.

Table 1
Percent (%) of Participants in Various Duty Positions during Combat Tours

Duty Position	% Tested only at Baseline (n = 23)	% Tested at Baseline and Recall (n = 54)
Platoon Leader	57	54
Operations Officer (S3, AS3, S3 AIR)	13	15
Executive Officer	17	13
Logistics Officer (S4)	0	7
Battle Captain	9	2
Liaison Officer	0	2
Fire Support (FDO, FSO)	0	2
Information Management Officer (S6)	0	2

Comparing the baseline only group to the participants who attended both measurement sessions on other measures similarly failed to identify differences. Those tested only at baseline were comparable to the others in terms of FBCB2 training and experience, self-rated FBCB2 proficiency, general computer experience, and baseline performance on the FBCB2 knowledge and hands-on tests (see Table 2). Comparisons across the two groups with independent sample *t*-tests and chi-square analyses did not reveal significant differences for any of these measures. Thus, the factor or factors that resulted in 23 individuals not returning for the recall test did not appear to differentially affect participants along any of the dimensions measured.

Table 2
Mean Scores of Those Who Attended the Baseline Session Only versus Those Who Attended Both Sessions

Measure	Tested Only at Baseline (n = 23)	Tested at Baseline and Recall (n = 54)
Officer Basic Course FBCB2 training (hours)	0.6	0.5
New Equipment Training (NET) FBCB2 (hours)	3.1	2.7
FBCB2 use in combat (months)	8.6	7.7
Self-rated FBCB2 proficiency [a]	1.1	1.2
Percent using any digital system in combat	79.0	80.0
Composite computer experience [b]	5.3	4.8
Baseline knowledge test score [c]	8.6	10.2
Baseline hands-on test score [d]	22.8	27.4

Note. [a] Self-ratings were on a scale of 0 – no experience, 1 – basic experience, 2 – medium experience. Experience levels are defined in the *Measurement Instruments* section. [b] Composite computer experience scores ranged from 0 to 24. High values reflect more computer experience. [c] Possible knowledge test scores ranged from 0 to 22. [d] Possible hands-on test scores ranged from 0 to 35. The computer experience scoring, knowledge test, and hands-on test are described in the *Measurement Instruments* section.

Measurement Instruments

Participants completed three separate instruments in both the baseline and recall measurement sessions: A questionnaire regarding experience and training on digital systems, a test of knowledge of various FBCB2 functions and capabilities, and a hands-on ability test of 13 FBCB2 tasks. These three instruments are described in detail below, and all the instruments used in both measurement sessions can be found in Appendix B.

Experience and training questionnaire. For the baseline session, participants were asked a set of five questions regarding their experience and training on ABCS systems. In the first question, participants indicated types of individual operator training they had received and the hours of instruction for each type of training. Types of training included online courses and new equipment training. In the second question, they completed a checklist to indicate the types of collective training they had received on ABCS systems. Types of collective training included motor pool training, and various field training or command post exercises (CPXs). In the third question, participants listed the systems they had used while deployed to a combat theater, their duty positions while using the system and the number of months they used the system.

In question four, participants rated their overall proficiency on ABCS systems on a four-point scale. The levels of the scale were: 0 - never used, 1 - basic, 2- medium, 3 -high ability. Nobody rated themselves as having high ability on any of the systems so the scores in fact varied from 0 to 2. There were behavioral descriptors of each level that reflected how much of the system they understood, how often they had to ask for help, and how often they were asked for

help by others (full descriptions of the scales are in Appendix B). At a basic level, individuals were saying that they could use the system to perform a limited set of functions. At the medium level participants were saying that they were knowledgeable about most of its functions and had limited troubleshooting experience. At the high level, participants would be saying that they had advanced knowledge of the system and were often asked for help by others.

In the final question, participants completed a checklist indicating general computer experience on Windows, Macintosh, and Linux operating systems. In this checklist, they indicated whether or not they had used application software, installed software, installed software patches, installed hardware, changed boot-up options or Basic Input and Output System (BIOS) settings, authored web pages using software on that system, or authored software for that operating system. To reduce the responses in this checklist to a single number, the total number of checks across all operating systems was tallied for each participant. This score, composite computer experience, could range from zero (indicating no experience on any of the three systems) to twenty-four (indicating extensive experience using all operating systems).

In the recall session, the training and experience questions were not repeated as there was no reason to think that the answers would have changed while the students were in the ICCC (the question pertained to training received prior to ICCC). There was, however, the possibility that they could have used FBCB2 in a training exercise during the eight weeks between the two testing sessions, so they were asked whether they had used FBCB2 during that time. If they answered in the affirmative, they were asked to list the duration of operation in hours. None of the participants indicated that they had used FBCB2 during the intervening period.

Knowledge test. The knowledge test consisted of ten questions. The items on this test were identical for the baseline and recall tests. Officers were asked to describe what FBCB2 stands for, to name the four main areas of the operations screen, and to explain how to speed up a system that is running unusually slowly (the complete knowledge test is in Appendix B). A subject matter expert (SME) with experience training FBCB2 users generated the questions and answers. Digital trainers at Fort Benning, Georgia verified that all questions and answers were consistent with the material covered in the course.

All of the questions were fill-in-the-blank except one. Six of the fill-in-the-blank questions had multiple components (e.g., "Name the 2 screens on the FBCB2 system."). In such cases, officers were given credit for each component that was answered correctly. Project researchers developed the scoring criteria and tested them on a randomly selected subgroup of tests from the baseline measurement. All knowledge tests were then scored independently by two raters and the responses were compared. When differences occurred between the scores of the two raters, they discussed those differences and came to a consensus. The scoring criteria used by the raters are included in Appendix C.

As the completed tests were being scored, it became apparent to the scorers that one of the ten items (#6, "What is meant by a near real-time update?") was problematic. The course instructors had covered this topic in a more general way than the experimenters had initially understood. The end result was that most of the students simply restated the question (e.g., "It updates after a short delay" or "It doesn't update in real-time"). Applying the original scoring

criteria meant that almost none of the officers would have received credit, but modifying it meant that nearly all responses would receive credit. For this reason, we decided to exclude this item from further analyses. The remaining nine questions involved a total of 22 separate responses on the knowledge test.

Hands-on test. The officers completed a 13-item, hands-on test in both the baseline and recall sessions. Each officer used a computer running the FBCB2 software to complete the tasks. All officers completed the hands-on test individually. There was no time limit, but the average time taken to complete the hands-on test during the baseline test was 28 min (range 10-44 min) and the average time used to complete the recall test was 35 min (range 8-51 min). Times were recorded by the officers as described in the next section.

Just as with the knowledge test items, the items on the hands-on test were initially developed by an SME with experience teaching FBCB2 to Soldiers. The digital instructors at Fort Benning verified that test items were covered during the two-day training received by the ICCC students. (The items for both hands-on tests appear in Appendix B.)

To score the hands-on test, a data collection sheet was developed (see Appendix C). This form contained a series of predominantly yes/no questions for each task on the test (one question for task 11 required the experimenter to indicate the number of waypoints on the route). Scoring was based on observable files, folders and settings created by the officer taking the test. For example, in task 3, officers were asked to position their icon on the map. On the data collection sheet, an experimenter checked for two things: a) whether the icon was present on the map and b) whether the grid coordinates of the icon's location were correct. Thus, this item had a maximum score of two. Whenever an error occurred, a description of the error was recorded on the data collection sheet. For example, if the grid coordinates were incorrect for task 3, the experimenter recorded the grid coordinates that were entered by the officer. All computers were independently checked by two data collectors. When there was a disagreement, both raters looked at the system and came to a consensus.

The baseline and recall tests had the same tasks and task order. However, some details of the tasks were altered on the recall test to avoid a rote response; intent was to evaluate procedural recall, not memorization of a specific answer. For example, in task 3, participants were asked to manually place their icon on the map, but the coordinates where the icon was to be placed varied across the two tests. Other differences between the tests included the names of files or folders that officers were supposed to create as well as changes to some of the settings they were to make. Only the wording for tasks 1, 2, and 12 remained completely unchanged across the two tests. Although the wording for task one was the same on both tests ("What is the role your computer is set to?"), none of the officers were seated at the same station during the recall test (which took place in different classrooms) so their workstation role had changed. All tasks for the baseline and recall hands-on tests are included in Appendix B.

All tasks had the same maximum score in both the baseline and recall sessions with one exception. Task nine—create, save, and send a SPOT report—had a maximum score of 10 for the baseline session and 12 for the recall session (officers had to account for one more enemy unit in the recall session than in the baseline session). This variation meant that there was a

maximum score of 35 for the baseline hands-on test and 37 for the recall test. To make the results across the two sessions directly comparable, the percent of the maximum score served as the measure of choice for all items. During the baseline session, several participants were observed using the online FBCB2 help function. We did not anticipate this possibility on the baseline measurement so an item was added to the recall test asking officers to indicate whether or not they used the online help function for each task.

Procedure

The FBCB2 knowledge and operator skill measurements were taken at two points in time. The first measurement occurred at the conclusion of two days of FBCB2 familiarization training, and the second measurement followed exactly eight weeks (56 days) later. The two-day training was part of the normal ICCC program of instruction. During the FBCB2 training, the instructors covered start-up and shut-down procedures, and then all of the major functions of the system. Most of the instruction followed a common pattern of demonstrating a procedure while the students repeated the steps on their own system, and then having the students complete a practical exercise using that procedure.

Testing took place in digital classrooms designed specifically for training personnel how to use FBCB2. These classrooms were identical and had about 44 computer workstations with FBCB2 software installed. The monitors were mounted below a plate glass desktop and were facing upward so they could be easily viewed through the glass desktop. This configuration also made it difficult for officers to see any adjacent or nearby monitors.

For the baseline session, at the conclusion of their FBCB2 training, the officers took a 15-min break. Upon returning, each participant received a packet containing a privacy act statement plus the three measurement instruments—experience and training questionnaire, knowledge test, and hands-on test. Following introductory comments, participants were instructed to complete the first two of the three instruments and then stop and wait for further instructions. The additional instructions explained how to record start and stop times for each hands-on task. Because all of the officers executed the tasks simultaneously at their own pace, it was necessary to have them record their own start and stop times. The start time was to be recorded after they had read the instructions but before they began to perform the task. They were to record the stop time when they had completed the task and closed all dialogue boxes. To illustrate this procedure, the proctor demonstrated a task to indicate when start and stop times should be recorded. This task—using the circular line-of-sight tool—was not part of the hands-on test.

A digital clock was displayed on projector screens at the front of the classroom and the officers were asked to record times from that clock. Times were recorded to the nearest second. If an individual could not complete the task, he was instructed to write "unable to complete" on his data sheet. If an individual forgot to record either the stop or start time, he was instructed to go back and repeat the task, recording those times and indicating that they were based on a second performance of the task. Officers were told to proceed at their own pace and to raise their hands when they completed all 13 tasks. An experimenter checked each officer's materials to make sure that they were properly completed, then released the participant. On the recall test, once all officers were seated, the session was conducted exactly like the baseline session.

After all officers were released, two experimenters checked each machine using the hands-on data collection instrument included in Appendix C. If there were discrepancies between the data recorded by the two experimenters, they resolved those differences before exiting the classroom. For the recall session, the officers were told which of two digital classrooms to report to based on an alphabetical sorting of their last names.

Results

Experience and Training

In their responses to the questionnaire on ABCS training and experience, participants indicated that they had received a range of both individual and collective training experiences (see Tables 3 and 4). Individual training occurred more frequently on FBCB2 than the other systems, although only a minority of participants (less than 20%) received any given type of training. The bias for training on FBCB2 probably reflects the fact that students were infantry officers who had led and commanded at the platoon and company levels. The ASAS is a military intelligence system and AFATDS is a field artillery system, while MCS is found at the battalion level and above—so it is not surprising that few if any officers tested had prior experience with any of these systems.

Nobody reported taking online training or the Digital Master Trainer course. Only 11% of participants had received new equipment training (NET) on FBCB2. Interestingly, the most frequent type of individual training for FBCB2 was "other" which was consistently defined by participants as on-the-job training received while they were deployed to Afghanistan or Iraq.

Table 3
Percent (%) of Participants Who Received Individual Training on Digital Systems

Type of Training	None	FBCB2	ASAS	MCS	AFATDS
Online Course	100	0	0	0	0
Officer Basic Course	90	4	0	0	6
NET	87	11	0	2	0
NET Delta	98	2	0	0	0
Digital Master Trainer	100	0	0	0	0
Other	82	17	0	2	0

Note. NET = New Equipment Training, NET Delta = NET on software changes only. "Other" training occurred on-the-job while deployed to Iraq or Afghanistan.

Only a minority of the participants (30% or less) received collective unit training on a specific ABCS system (see Table 4). As with individual training, FBCB2 was the system for which most individuals received any collective training. Motor pool training with FBCB2, the most frequently reported type of collective training, was claimed by only 30% of the participants. Field training exercises (FTXs) and CPXs accounted for most of the remaining collective unit training received by the participants on FBCB2.

Table 4
Percent (%) of Participants Who Received Collective Unit Training on Digital Systems

Event	None	FBCB2	ASAS	MCS	AFATDS
Motor Pool Training	65	30	0	4	6
FTX at Home Station	81	17	0	2	0
FTX at a Combat Training Center	89	11	0	2	0
CPX at a Digital Training Facility	83	15	0	0	2
CPX at Home Station	87	11	0	0	2
CPX at a Combat Training Center	98	0	0	0	2
Other	93	7	0	4	2

Note. "Other" was consistently described as on-the-job training while deployed to Iraq or Afghanistan.

As stated in the Methods section, 80% of the participants had experience using a digital system in combat, and most of those gained their experience in Iraq (81%) rather than Afghanistan (19%). Nearly three quarters of the participants used FBCB2 in a combat theater (see Table 5), while only a small fraction (6% or less) used any of the other systems in combat.

Table 5
Combat Use of Digital Systems Reported by Participants

Measure	Any System	FBCB2	ASAS	MCS	AFATDS
% Who Used System in Combat	80	72	2	6	4
Average # Months Used	7.9	7.9	10.0	7.0	8.0

Consistent with their training and experience, which favored the FBCB2 system, 89% of the participants rated themselves at either a basic or medium level of proficiency on FBCB2. In contrast, fewer than 15% rated themselves at a basic or medium level of proficiency on any of the other systems (see Table 6).

Table 6
Self-Ratings of Operator Ability (% of Participants)

Self-Rating	FBCB2	ASAS	MCS	AFATDS
Never Used	11	98	87	93
Basic	59	2	9	7
Medium	30	0	4	0
High	0	0	0	0

When participants indicated the kinds of experiences they had with personal computers, their responses reflected the prevalence of the Windows operating system on personal computers (see Table 7). Many participants indicated they had installed software, patches and hardware on

Windows systems. Almost one third had authored web pages or changed boot-up options and altered BIOS settings. In contrast, most officers indicated they had no experience with the Macintosh (72%) or Linux (81%) operating systems.

Table 7
General Computer Experience (% of Participants)

	Operating System		
Activity	Windows	Macintosh	Linux
Never used this operating system	0	72	81
Used application software	94	2	2
Installed application software	81	0	0
Installed software patches	56	0	0
Installed hardware	48	0	0
Changed boot-up options	31	0	0
Changed BIOS settings	30	0	0
Authored web pages using software on this system	31	0	0
Authored programs for this operating system	17	0	0

To better understand how the various training and experience measures are related, Pearson correlations were calculated using several composite measures. These included the sum of all hours of FBCB2 operator training, total number of collective FBCB2 training experiences, total months of FBCB2 use in combat, self-rated FBCB2 proficiency, and composite computer experience. As shown in Table 8, self-rated FBCB2 proficiency correlated significantly and positively with all other training and experience measures except for composite computer experience. Interestingly, composite computer experience did not correlate significantly with any of the other measures of training or experience.

Table 8
Correlations among Measures of Experience and Training

Measure	Collective FBCB2 training	Months using FBCB2 in combat	Self-rated FBCB2 proficiency	Composite computer experience
Total hours of FBCB2 training	.37 **	.24	.45 **	.10
Collective FBCB2 training		.20	.37 **	.10
Months using FBCB2 in combat			.50 **	.14
Self-rated FBCB2 proficiency				.18

** $p < .01$

Knowledge Test Performance and Retention

Overall performance analysis. The knowledge test questions asked participants to recall various characteristics of the FBCB2 system. Of the nine questions scored (recall that question 6 was ignored), six had multiple components resulting in a total of 22 separate responses on this test. The responses to the knowledge test were analyzed from the standpoint of (a) the total number of questions answered correctly (i.e., all components of a question had to be answered correctly to get credit for a question) and (b) the total number of components answered correctly. There were nine questions so the question score could range from 0-9; and there were 22 components so the component score could range from 0-22.

The average question score on the baseline test was 3.6 (40% correct) and the average on the recall test was 3.4 (38% correct). The average component scores were 10.17 points (46.2%) on the baseline test and 10.24 (46.5%) on the recall test. Neither of the changes was statistically significant.

Table 9 gives the correlations between measures of performance on the knowledge test. Included are the baseline and recall test scores for both the component and question measures. As was expected, most of these measures correlated significantly and positively with each other. For example, the baseline question and component scores correlated positively with the recall question and component scores, meaning that high recall scores were predicted by high baseline scores.

Table 9
Correlations among Knowledge Test Scores

		Question Score	
	Component Score (Recall)	Baseline	Recall
Component score (baseline)	.68 **	.86 **	.45 **
Component score (recall)		.58 **	.72 **
Question score (baseline)			.42 **

** $p < .01$.

Item analysis. Despite the negligible forgetting overall, there were some sizable changes in performance on individual questions. Table 10 presents the percent of the sample that correctly answered each question on the knowledge test.

Chi-square tests were performed to compare the proportion that answered each question correctly on the recall test as compared to the baseline test, using McNemar's (1975) method for correlated proportions. There was significant forgetting on only one of the questions, # 5. Interestingly, there was a significant improvement in performance on two of the questions, #7 and #1. The chi-square values and exact alpha levels are provided in Appendix D.

Table 10
Percent (%) of the Sample Answering Each Question Correctly on the Knowledge Test

Question	Baseline	Recall	Difference
5. Packet mode message size limit?	69	24**	-45
3. The two system screens are?	15	4	-11
2. FIPR stands for what?	46	39	-7
10. Time zone to enter reminders?	74	70	-4
9. Advantage of FBCB2 and BFT?	0	0	0
4. Four main areas of Ops screen?	0	2	2
8. How to speed up a slow system?	67	76	9
7. LOS tool determines what?	48	67*	19
1. FBCB2 stands for what?	43	63*	20
Overall	40	38	-2

Note: FIPR = Flash, Immediate, Priority, Routine (categories of message importance), BFT = Blue Force Tracking, LOS = line of sight.
** $p < .01$, indicating that more individuals decreased than increased. * $p < .05$, indicating that more individuals increased than decreased.

Table 11 presents the percent of the sample correctly answering the components of each question. McNemar chi-square analyses were performed on the 6 questions that had multiple components to highlight significant changes across the two tests (see Appendix D). Question 5, the only question on which performance declined significantly, had only one component, so it is not included in Table 11. Interestingly, for question #7, although the question performance improved significantly, performance did not improve significantly on either of the components. This suggests that a similar number of errors was made on the baseline and recall tests but those errors were made by fewer individuals on the retest. For question #1, the improvement in recall for the acronym "FBCB2" was driven largely by an improvement in recall of "Force XXI" and "brigade and below" although recall for all letters of the acronym did increase across the two tests. For question #4 (list the four main areas of the operations screen), performance did not change on the question score but there was a decline in the component scores. Specifically, there was a significant decline in remembering the classification banner and operations function bar.

An examination of the errors made on the recall test is useful for understanding what was typically forgotten. For example, in questions 1 and 2, participants were asked to spell out acronyms (FBCB2 and FIPR, respectively). Recall for "FBCB2" improved significantly while recall for "FIPR" declined slightly. Those who made mistakes on question 1 (FBCB2) often only missed one word (8 individuals). The mistakes were often not too different from the correct word (e.g., battlefield in lieu of battle, or communications in lieu of command). Everyone who attempted to answer got at least one word correct and only seven gave no response. In contrast, when answering question 2 (FIPR) participants either knew the answer or they didn't. Only 10 individuals received partial credit. The remaining 44 were split between full credit (21 participants) and no credit (23 participants).

Table 11
Percent (%) of the Sample Answering Each Component Correctly on the Knowledge Test

Question and Components	Baseline	Recall	Difference
3. Name the two screens on FBCB2.			
Session manager	15	6	-9
Operations	41	28	-13
2. What does FIPR stand for?			
Flash	48	41	-7
Immediate	48	44	-4
Priority	59	57	-2
Routine	46	44	-2
9. List one advantage to FBCB2 and BFT.			
FBCB2	0	0	0
BFT	20	19	-1
4. What are the four main areas of the Ops screen?			
Classification banner	20	7 *	-13
Map display	39	46	7
Operations function bar	19	4 *	-15
Communications/FIPR queue	11	7	-4
7. The LOS tool allows the Soldier to determine?			
Bearing	56	72	16
Range	69	83	14
1. What does FBCB2 stand for?			
Force XXI	56	76 **	20
Battle	67	78	11
Command	70	80	10
Brigade and	65	83 *	18
Below	59	76 *	17

* $p < .05$, ** $p < .01$ indicating that the proportion answering correctly on the recall test was significantly different from the proportion answering correctly on the baseline.

On the recall test for question 3, name the two FBCB2 screens, about half of those who got no credit (21 of 39 participants) did not even venture a guess, indicating that they had no recollection of the answer. Participants were more likely to recall the operations screen than the session manager screen which was not surprising as most work on FBCB2 is done on the former screen. The most common mistakes naming this screen involved assigning names related to its function, such as "map", "maneuver", or "navigation."

When asked to name the four main areas of the operations screen in question 4 of the recall test, participants clearly struggled. About half of the participants (25 individuals) recalled that the map was one area, but fewer than five were able to recall any of the other areas. A number of answers indicated that they recalled the function of the area though they could not recall the exact name of the area. For example, 14 individuals listed “message line” or “message bar” instead of FIPR queue. Several also mentioned a “toolbar” or “tools” by which they probably meant the function bar.

Participants performed at a chance level on question 5, the only multiple choice question of the test (24% correct on a four-choice question). For some reason, the most popular selection was 1280 KB (39% of the sample). This may indicate a guessing strategy of avoiding the extremes as it was the second largest value among the four choices (the correct answer was 1450 KB, the largest value). There was nothing intuitive about this question and to answer correctly, participants would simply have to recall the correct figure.

Questions 7 and 8 on the other hand were both relatively intuitive for someone with a military background, and consequently participants did well on them. Question 7 asked them to list information provided by the LOS tool. Only three individuals left the question blank, and only three who attempted to answer received no credit. When asked how to speed up a slow system in question 8, only one person did not respond; of the thirteen with incorrect responses, seven said either restart or reboot the system. These were not given credit because clearing logs and queues is not really a system reboot. Furthermore, this response may have been a guess as rebooting a Windows system is a common remedy for a computer that is running slower than it should.

In question 9, list one advantage of FBCB2 and BFT, few participants answered correctly. Twenty-nine (54%) of the participants said they did not know the answer or left at least one of the parts blank. None of the participants knew an advantage for FBCB2 (larger bandwidth) although some said that it was faster. Ten participants knew an advantage of BFT (signal is not impeded by terrain). Most of the incorrect responses represented general advantages of both systems (e.g., track friendly forces, avoid fratricide) but failed to note advantages of one system over the other.

Finally, in question 10, participants were asked to indicate what time zone must be used for periodic reminders. Most of the participants recalled that it was Zulu or Greenwich Mean Time but 16 did not. Of those 16, 13 responded with "local time." It is not clear why there was such consistency among those who got this question wrong other than it seemed a logical guess.

Hands-on Test Performance and Retention

Overall performance analysis. The hands-on test entailed 13 tasks (see Appendix B) performed on an FBCB2 workstation. Scoring of each task depended on the observable footprint left on the FBCB2 workstation (e.g., checking to see that an icon was in the right location). As with the knowledge test, a task score (analogous to the knowledge test question score) reflected the number of tasks for which all components were performed correctly. Hands-on task scores ranged from 0-13. In addition, a hands-on component score (analogous to the knowledge test component score) was derived to reflect the number of task components completed correctly. There were a total of 35 components on the baseline test and 37 components on the recall test. Because the number of components varied across the two tests, the analysis was done on the percent of components performed correctly.

As seen in Figure 1, performance summed across the 13 tasks showed modest (10%) decay. In the baseline, the participants completed an average of 72% of the tasks correctly without errors in any of the components and this dropped to 62% in the recall test. Analysis of

variance revealed the test-retest effect was significant, $F(1,53) = 17.07, p < .001$. When looking at component scores, less decay was seen. Component scores averaged 78% correct in the baseline test and 73% correct in the retest. The modest (5%) decrease was statistically significant, $F(1,53) = 4.09,\ p < .05$.

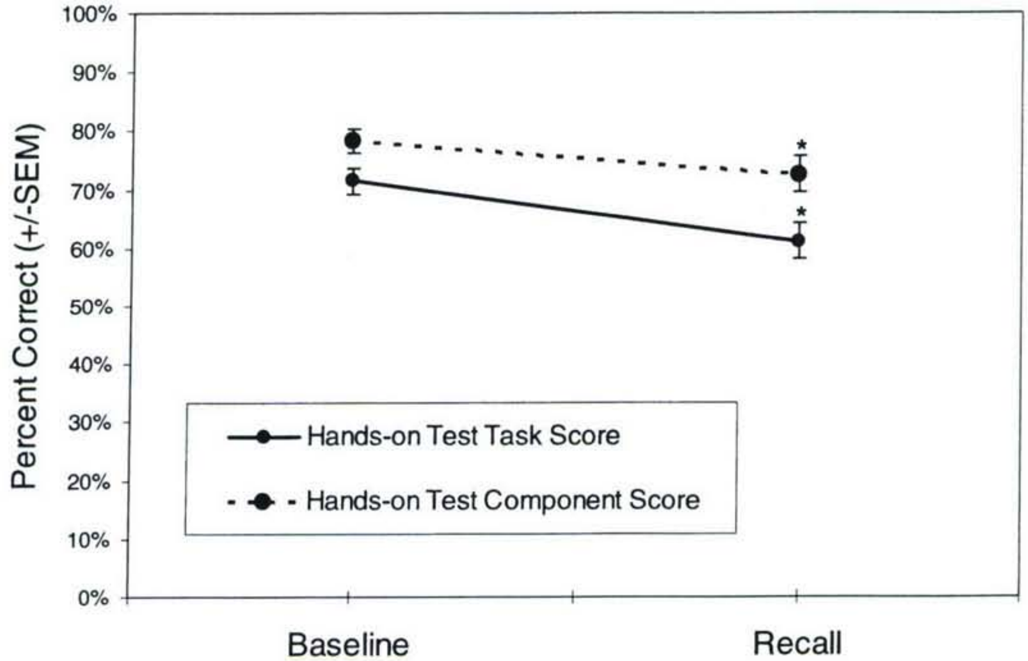

Figure 1. Mean scores on the hands-on baseline and recall tests.

Table 12 presents the correlations among the overall component and task scores on the baseline and recall test scores. As with the knowledge test, there were significant, positive correlations among the baseline and recall tests. This indicates that high scores at baseline were related to higher scores at recall. The highest correlations were between the component and task scores at baseline and similarly between these two scores at recall.

Table 12
Correlations among Hands-on Test Scores

	Component Score (Recall)	Task Score Baseline	Task Score Recall
Component score (baseline)	.45 **	.85 **	.60 **
Component score (recall)		.47 **	.92 **
Task score (baseline)			.61 **

** $p < .01$.

Item analysis. Table 13 shows the percent of the sample correctly performing each of the 13 tasks. To compare performance across the two testing periods, McNemar chi-square analyses were performed on the recall data for each task (see Appendix D for chi-square statistics). Chi-square results indicated that there was a significant decline in performance on three of the thirteen tasks. The tasks are arranged in Table 13 with those showing the greatest loss at the top. Compared to the mean decline of 10% across all tasks, the tasks showing a significant decline exceeded this value by a factor of two or more.

Table 13
Percent (%) of the Sample Correctly Performing the 13 Hands-on Tasks

Task	Baseline	Recall	Difference
12. Position and center icon on map[a]	87	63 **	-24
11. Create route on map	46	26 *	-20
6. Create address group	74	55 *	-19
2. Clear logs and queues	33	18	-15
7. Set free text defaults	65	52	-13
3. Position icon on map	76	63	-13
10. Save incoming message	91	78	-13
4. Adjust SA settings	89	78	-11
5. Create message folders	100	91	-9
1. Verify platform role	93	91	-2
8. Create/send free text message	85	85	0
9. Create/send SPOT report	22	24	2
13. Check line of sight	69	72	3

[a] Task 12 was not independent of task 3 because to center the icon on the map, it must first be placed on the map.
* $p < .05$, ** $p < .01$.

It is important to note that task 12, center the icon on the map, could not be executed unless part of task 3, position the icon on the map, was done successfully. The data for task 12 in Table 13 reflect this dependency, showing that the percent of participants who accomplished both tasks declined significantly. If only those people who succeeded in placing their icon on the map (whether or not it was in the correct location) are examined, there is only a small, non-significant decline in their ability to also center the icon (90% on the baseline test vs. 87% on the recall test). Thus the significant decline in performance on task 12 is primarily due to forgetting how to get the icon on the map, not how to center the icon.

To better understand exactly which component of each of the hands-on tasks contributed most to forgetting, the performance on each component of every task was examined (see Table 14). In cases where there was only one component for a task, the percentages are the same as those shown in Table 13, therefore they are not repeated in Table 14. Of the 33 components

analyzed, four showed a significant decline and one showed a significant increase (see also Appendix D).

Table 14
Percent (%) of the Sample Correctly Completing Components of Each Hands-on Task

Task and Components Checked	Baseline	Recall	Difference
11. Create route			
Route displayed on screen	72	41 **	-31
Route named correctly	93	83	-10
Route number of waypoints correct	57	48	-9
6. Create address group			
Address group named	82	72	-10
Address group addressee correct	74	56 *	-18
2. Clear logs and queues			
One message in FIPR queue	72	67	-5
No old messages	80	78	-2
No other directories	41	30	-11
3. Position icon on map			
Icon visible on map	100	72 *	-28
Icon location correct	76	63	-13
7. Set free text message defaults			
Free text message default address set	74	54 *	-20
Free text message default precedence set	78	76	-2
Free text message default acknowledge set	80	76	-4
4. Adjust SA settings			
SA: stale setting correct	89	80	-9
SA: old setting correct	89	83	-6
SA: purge setting correct	89	82	-7
5. Create message folders			
Directory 1 named	100	94	-6
Directory 2 named	100	91	-9
8. Create/send free text message			
Free text message sent	93	91	-2
Free text message addressee correct	85	85	0
9. Create/save/send SPOT report			
SPOT report in folder	82	89	7
SPOT report named correctly	54	48	-6
SPOT: entity 1 indicated	82	83	1
SPOT: entity 1 location indicated	63	82 *	19
SPOT: entity 1 status indicated	83	89	6
SPOT: entity 1 activity indicated	82	82	0
SPOT: entity 2 indicated	82	82	0
SPOT: entity 2 speed indicated [a]		82	
SPOT: entity 2 direction indicated [a]		82	
SPOT: precedence set	48	41	-7
SPOT: report sent	85	72	-13
SPOT: addressee correct	48	59	11

Table 14 (continued)

Task and Components Checked	Baseline	Recall	Difference
13. Check line of sight			0
LOS trace displayed	70	72	2
LOS height correct	74	80	6

Note. Tasks 1, 10, and 12 each had only one component so they are not repeated in this table.
[a] These items were present in only the retest, not the baseline.
$^{*}p < .05$, $^{**}p < .01$.

Not all components of each task were forgotten equally. For example, performance on task 11 declined significantly overall, but this decline was primarily due to participants forgetting how to keep the route displayed on the map. Participants did not forget how to name the route or add the correct number of waypoints (Table 14). For task 6, created address group, individuals remembered how to name the address group but they forgot how to assign the correct addressee.

There were significant changes in performance on components of two other tasks even though there was no significant decay on the overall task scores. For task 3, position icon on map, there was significant decay for putting the icon on the map but no decay for putting it in the correct location. On task 7, set free text message defaults, participants forgot how to set the default addressee but not how to change the precedence and acknowledgement settings. On task 9 (create, save, and send a SPOT report), participants actually improved their ability to indicate the location of the first entity, but showed no changes in performance on any of the other components.

Common Errors on the Recall Test

As with the knowledge test, an examination of the incorrect responses to the hands-on tasks sheds some light on the nature of what was forgotten. For some of components of the hands on tasks, it was only possible to know whether or not the procedural step was completed. However, for several of the components, it was possible to examine the nature of the mistakes that were made. What follows is a discussion of the types of errors made on the components of the hands-on tasks in the recall test. These errors are also summarized in Table 15.

On the first task, copying the assigned role of the system, almost everyone was able to perform this task. Judging by the responses of the four individuals who did not get credit for this task, they did not appear to know what they were looking for since they entered various phrases or labels on the screen (e.g., "NAV", or "Commsat: GO") or they attempted to copy the roles from nearby participants.

On task 2, clear logs and queues, 44 of 54 (81%) were unable to perform this task. There was no way to determine which step in clearing logs and queues was most easily forgotten, but it is interesting to note that more individuals used help on this task than on any other task (see Table 16). Only 34 of 54 (63%) of the participants were able to place their icon on the correct map location for task 3. Of the 20 who did not get credit on this task, 14 were not able to place their icon on the map at all. The remaining six individuals were able to place their icon on the

map but put it in the wrong location, most likely because they simply clicked on the map rather than entering the exact coordinates.

Table 15
Rates for Types of Errors Made on the Hands-On Recall Test

Task and Error Description	# making errors	Percent of sample	Percent of those making errors
1. Verify platform role	5	9%	
did not know what to look for	4	7%	80%
transcription errors	1	2%	20%
4. Adjust SA settings	12	22%	
changed settings with errors	3	6%	25%
did not change from default	9	17%	75%
5. Create two message folders	5	9%	
created only one folder	2	4%	40%
did not create any folders	3	6%	60%
6. Create address group	24	44%	
did not create address group	14	26%	58%
wrong addressee due to failure to check search result	8	15%	33%
wrong addressee	2	4%	8%
address group named incorrectly	1	2%	4%
7. Set free text message defaults	26	48%	
no addressee	11	20%	42%
precedence left at default	10	19%	38%
wrong addressee due to failure to check search result	10	19%	38%
precedence incorrect (not default)	3	6%	12%
self addressed	2	4%	8%
8. Create/send free text message	8	15%	
wrong addressee due to failure to check search result	8	15%	100%
failed to send	5	9%	63%
9. Create/send SPOT report	41	76%	
precedence left at default	25	46%	61%
message name left at default	19	35%	46%
no addressee/not sent	10	19%	24%
message named incorrectly (not default name)	9	17%	22%
wrong addressee due to failure to check search result	8	15%	20%
precedence incorrect (not default)	7	13%	17%
no message created	3	6%	7%
self addressed	1	2%	2%
10. Save incoming message	12	22%	
saved in wrong location	4	7%	33%
did not save message	8	15%	67%

Table 15 (continued)

Task and Error Description	# making errors	Percent of sample	Percent of those making errors
11. Create route on map	40	74%	
route was not displayed	32	59%	80%
route had more than 5 waypoints	21	39%	52%
no route was created	7	13%	18%
route had default name	2	4%	5%

Note. To avoid redundancy with Table 14, information is provided only for those tasks in which information about the nature of the errors is available.

Most participants were able to perform tasks 4 and 5. When asked to change the situation awareness settings in task 4, nine individuals were completely unable to perform the task (with settings remaining at default values) and three individuals changed the settings, demonstrating they knew what to do, but they made errors in their changes. Most everyone was able to perform task 5, create two message folders. Only three participants could not create any folders, and two created one folder demonstrating they knew the process.

In tasks 6, 7, 8, and 9, participants were asked to create and/or address various types of messages. An error common to all four of these tasks stemmed from using the search function to find an addressee. The address book search function in FBCB2 does not always return an exact match to the search string, even when one exists. For this reason, it is always important to double check the search result before selecting the addressee. For tasks 6-9, using the address book search function returned a close, but incorrect, addressee (deputy commander vs. commander). Participants who did not check the search result before selecting it made errors. On all of these tasks, 20-100% of those who made errors misaddressed their messages because they did not carefully check the search result before selecting the addressee. Otherwise, assigning an address seemed to create problems for tasks 6-9. Often, participants were not able to assign an address at all, or wound up self-addressing the message.

In tasks 7 and 9, participants had to alter the precedence settings of the outgoing messages and this was the most common source of error for task 9. In task 7, half of those who made errors failed to set the precedence of the message correctly, and in task 9 over two-thirds of those making errors assigned the wrong precedence. Most commonly, participants left the precedence setting at its default value, indicating that they had forgotten how to change it.

Fewer participants had trouble with tasks 10 and 11. For task 10, display and save a message, only eight individuals were unable to save the message and four individuals saved it to the wrong location. For task 11, create a route, only seven individuals completely failed to create a route. The most common error on task 11 (made by 25 individuals) was that participants who created a route, failed to leave the route displayed. Another common error for task 11 was that too many waypoints were added to the route. Participants were instructed to create a route with five waypoints. Most commonly, participants generated six waypoints, an error that

probably resulted from failing to count their current location as a waypoint. Of those who made errors counting waypoints, 13 had six waypoints, five had seven, two had eight, and one had 11.

There were no insights regarding the errors made on components of tasks 12 and 13 because we were only able to ascertain whether or not participants completed those components.

Time to Complete Hands-on Tasks

In the baseline test, the participants took an average of 28.0 min total time to perform the hands-on test. The total elapsed time was computed by subtracting the Task 1 start time from the Task 13 end time, so it included the time spent reading directions and executing the tasks. The participants expended an average of 35.1 min in performing the recall test, for a mean increase of 7.1 min. The increase in time was significant, $t(50) = 6.47, p < .001$. [Note: Three participants had missing data in the baseline or recall test.]

For the thirteen tasks of the hands-on test, the average execution times appear in Table 16. For each task the means are based on all participants with valid times for *both* the baseline and recall tests (excluding outliers). Participants with valid times were included whether the recorded time was associated with correct, partially correct, incorrect, or incomplete performance. Data were analyzed in a series of repeated-measures *t*-tests to compare the time taken to complete each task in the baseline and recall tests. Table 16 places the tasks showing the greatest increase at the top.

Table 16
Mean Time Spent per Task in Hands-on Tests (Baseline and Recall)

Task	*n*	Baseline Mean (min)	Recall Mean (min)	Difference (min)
3. Position icon on map	48	1.55	3.02 **	1.47
2. Clear logs and queues [a]	47	3.77	5.07 **	1.30
6. Create address group	41	1.83	2.57 **	0.74
4. Adjust SA settings	53	0.85	1.48 **	0.63
9. Create/send SPOT report [b]	47	3.63	4.17	0.54
5. Create message folders	53	1.17	1.68 **	0.51
12. Center icon on map	45	0.11	0.41 **	0.30
10. Save incoming message	47	0.67	0.87 **	0.20
7. Set free text defaults	47	1.20	1.38	0.18
1. Verify platform role	53	0.47	0.63 *	0.16
8. Create/send free text message	49	1.52	1.67	0.15
11. Create route on map	46	2.90	2.63	-0.27
13. Check line of sight	49	1.90	1.33 **	-0.57

[a] Clearing logs and queues included time for the FBCB2 workstation to reboot. [b] The recall version of this task included two more steps than the baseline version.
* $p < .05$, ** $p < .01$.

The results of the t-tests revealed that the baseline-retest differences were significant for nine of the tasks (eight cases increasing and one decreasing), as indicated in Table 16 (t-test statistics appear in Appendix D). As Table 16 shows, average execution times varied considerably across tasks, ranging from less than 7 sec to nearly 4 min in the baseline and from 25 sec to more than 5 min in the recall test. Simple difference scores (recall test mean minus baseline mean) revealed that the execution times increased by 0.15 min to 1.47 min for 11 of 13 tasks. This represented relative increases ranging from 10% to 273%. One task exhibited a significant decrease in mean execution time (30% decline), and a second task showed a slight decrease (9% decline).

Use of FBCB2's Help Function

The FBCB2's help capabilities were available to the participants throughout the test and retest sessions. The proctor neither discouraged nor encouraged the students to use the help features in performing the hands-on tasks. Only during the recall test were the participants asked to record whether they used the help feature for a given task. In that session, 27 participants (50% of the sample) reported using help on at least one task. Half of these indicated they used help more than once, but no more than five times. Those who used help at least once averaged 66.4% correct in the recall test, while those who did not did significantly better averaging 78.9% correct, $t(52) = 2.13, p < .05$.

Using help tended to increase the total time taken to perform all tasks in the hands-on recall test. Those reporting use of help at least once averaged 37.4 min overall, while those not using help averaged 33.1 min. Although the subgroup using help averaged more than 4 min longer working on the recall test, the difference was not significant, $t(51) = 1.58, p = .12$. The participants were not asked to indicate how much time they spent using FBCB2 help features, and any increase in total test time cannot be attributed solely to using help.

Table 17 shows the reported usage of help functions for each task in the recall test. In only three tasks did more than 10% of the 54 participants report using help: (a) clear logs and queues, (b) position icon on map, and (c) create an address group. In the case of clearing logs and queues, 31% of the participants reported using help. As can be seen in Table 17, few participants used the help function on any given task with the exception of task #2 (17 individuals). Interestingly, only 18% of the sample performed this task correctly on the recall test, the lowest percentage of all 13 tasks.

The reader should bear in mind that the participants' responses regarding use of help functions were not independently verified. When a participant failed to record "Yes" or "No" for using help on a task, a definitive response could not be inferred. Further, the participants were not asked to indicate if using help occurred before or during task execution, nor how much time they spent using help. Finally, it cannot be assumed that resorting to help produced the procedural information that a participant was seeking on a particular task.

Table 17
Self-Reported Usage of System Help in Retest by Task

Task	# Who Reported Using Help
1. Verify platform role	2
2. Clear logs and queues	17
3. Position icon on map	7
4. Adjust SA settings	3
5. Create message folders	2
6. Create address group	7
7. Set free text defaults	2
8. Create/send free text message	0
9. Create/send SPOT report	3
10. Save incoming message	0
11. Create route on map	3
12. Center icon on map	4
13. Check line of sight	0

Predictors of Knowledge and Hands-on Test Scores

Correlation analyses. The relationship between previous training and experience and performance on the knowledge and hands-on tests was examined. The analysis was performed by computing Pearson correlations between self-reports of training and experience and scores on the knowledge and hands-on tests. The training and experience measures included (a) self-rated FBCB2 proficiency, (b) hours of FBCB2 operator training, (c) total collective FBCB2 training experiences, (d) months of using FBCB2 in combat, and (e) composite computer experience. As Table 18 shows, collective training experience with FBCB2 was the best overall predictor of performance on the knowledge test. Similarly, self-rated proficiency was a good predictor of scores on the knowledge test. Total hours of FBCB2 training correlated significantly with the total number of items correct on the baseline, but not the retest.

Table 18
Correlations between Training and Experience and Knowledge and Hands-on Test Measures

	Component Score		Task Score	
	Baseline	Recall	Baseline	Recall
Knowledge Test				
Total hours of FBCB2 operator training	.31 *	.20	.22	.06
Total collective FBCB2 training experiences	.38 **	.31 *	.41 **	.38 **
Months using FBCB2 in combat	.11	.03	.14	.04
Self-rated FBCB2 proficiency	.39 **	.31 *	.35 **	.25
Composite computer experience	.23	.18	.24	.05

Table 18 (continued)

	Component Score		Task Score	
	Baseline	Recall	Baseline	Recall
Hands-on Test				
Total hours of FBCB2 operator training	.12	.09	.10	.03
Total collective FBCB2 training experiences	.14	.25	.16	.25
Months using FBCB2 in combat	-.15	-.01	-.11	-.09
Self-rated FBCB2 proficiency	.16	.34 *	.27	.25
Composite computer experience	.37 **	.38 **	.38 **	.43 **

$*p < .05$, $** p < .01$.

Interestingly, the only significant predictor of the hands-on test scores was composite computer experience. In contrast to the knowledge test, previous individual and collective training were not related to hands-on performance, although self-rated FBCB2 proficiency correlated significantly with the component score in the hands-on recall test.

The correlations between the knowledge scores and the hands-on scores revealed a number of significant, positive relationships as seen in Table 19. In general, the highest correlations occurred between recall scores on these two tests, accounting for 16% to 28% of the variance.

Table 19
Correlations between Knowledge and Hands-on Test Scores

	Knowledge Test Score			
	Component Score		Question Score	
Hands-on Test Score	Baseline	Recall	Baseline	Recall
Component (baseline)	.27 *	.27	.25	.22
Component (recall)	.41 **	.53 **	.41 **	.42 **
Task (baseline)	.32 *	.28*	.29 *	.23
Task (recall)	.37 **	.51 **	.40 **	.41 **

$*p < .05$, $** p < .01$.

Multiple regression analyses. In the unit, it would be relatively easy to collect general information about training history, experience and knowledge from individual operators of FBCB2 in order to predict skill decay over time. Accordingly, the experience and knowledge measures taken in this experiment were entered into a series of multiple regression equations to see if they would collectively predict performance variability on the hands-on test better than the knowledge test scores alone do. Total hours of FBCB2 training, the sum of collective FBCB2 training experience, total months of FBCB2 use in combat, self-rated FBCB2 proficiency, composite computer experience, and component score on the baseline knowledge test were all

entered into a standard regression model. Table 20 shows the multiple correlation coefficients for the hands-on test scores. As can be seen, the regression coefficients were significant for three measures of hands-on performance—component recall score, baseline task score, and recall task score.

Table 20
Multiple Correlation Coefficients (R) for Baseline and Recall Hands-on Test Results

Component Score		Task Score	
Baseline	Recall	Baseline	Recall
.45	.56 **	.50 *	.57 **

*$p < .05$, ** $p < .01$

Comparing the correlation coefficients in Table 20 to those in Tables 18 and 19, it can be seen that combining predictor variables improved the predictive model. For example, the multiple correlation coefficient for the recall component score was .56 but the individual predictors ranged from .03 to .41. The regression coefficient for the baseline task score was .50 and the individual predictors ranged from .10 to .32. Finally the regression coefficient for the recall task score was .57 while the individual predictor coefficients ranged from .03 to .43.

The effect of one final predictor variable was examined—task difficulty. To index task difficulty, the number of steps needed to complete each task in the hands-on test was determined with the help of SMEs. The number of steps ranged from 2 to 22 in the baseline test and from 2 to 24 in the recall test (see Appendix E for a list of all steps). For both tests, the median number of steps was 7 and the modal number was 5. Correlations between the number of steps for each task and the average score on that task for both the baseline and recall tests were calculated as a way to examine the relationship between number of steps and performance. As expected, these correlations were all negative indicating that as the number of steps increased, the average score on that task decreased. Correlation coefficients ranged from $r = -.28$ to $r = -.42$, but none reached statistical significance.

FBCB2 self-rated proficiency groupings. In the previous section, the degree to which self-rated FBCB2 proficiency (on a 3-point scale) was linearly correlated with the hands-on and knowledge test scores was examined. Those results indicated some small but significant positive correlations with knowledge and hands-on test performance indicating that higher self-ratings of proficiency were associated with better performance on the two tests. What these correlations don't reveal is whether participants in the three self-rated proficiency groups differed on their test scores. To address this question, self-proficiency ratings were used as a grouping variable for analyses of variance (ANOVA) to compare the never used, basic, and medium proficiency groups on their knowledge and hands-on test scores.

It is important to note that the sample sizes for this analysis are not equal. To avoid the confounding effects of unequal sample sizes, ANOVAs were performed using type III sums of squares which rely on unweighted means. Because only 6 participants reported they had never

used FBCB2, while 32 rated themselves at a basic level of proficiency and 16 rated themselves at a medium level, this type of analysis gave much more weight to the groups with no experience and medium proficiency than the correlation analyses in the previous section.

Four outcome measures were analyzed as dependent measures, while self-rated FBCB2 proficiency (no experience, basic proficiency, and medium proficiency) served as a between subjects factor and test (baseline vs. recall) served as a within subjects measure. The four outcome measures were the component and question/task scores for the knowledge and hands-on tests. The average scores for each group appear in Figure 2. In all four analyses, there was a significant main effect for self-rated proficiency with the never-use group scoring significantly lower than the medium and low proficiency groups (knowledge question score, $F[2,51] = 4.8$, $p = .01$; knowledge component score, $F[2,51] = 5.1$, $p = .01$; hands-on task score, $F[2,51] = 3.7$, $p = .03$; and hands-on component score, $F[2,51] = 4.0$, $p = .03$).

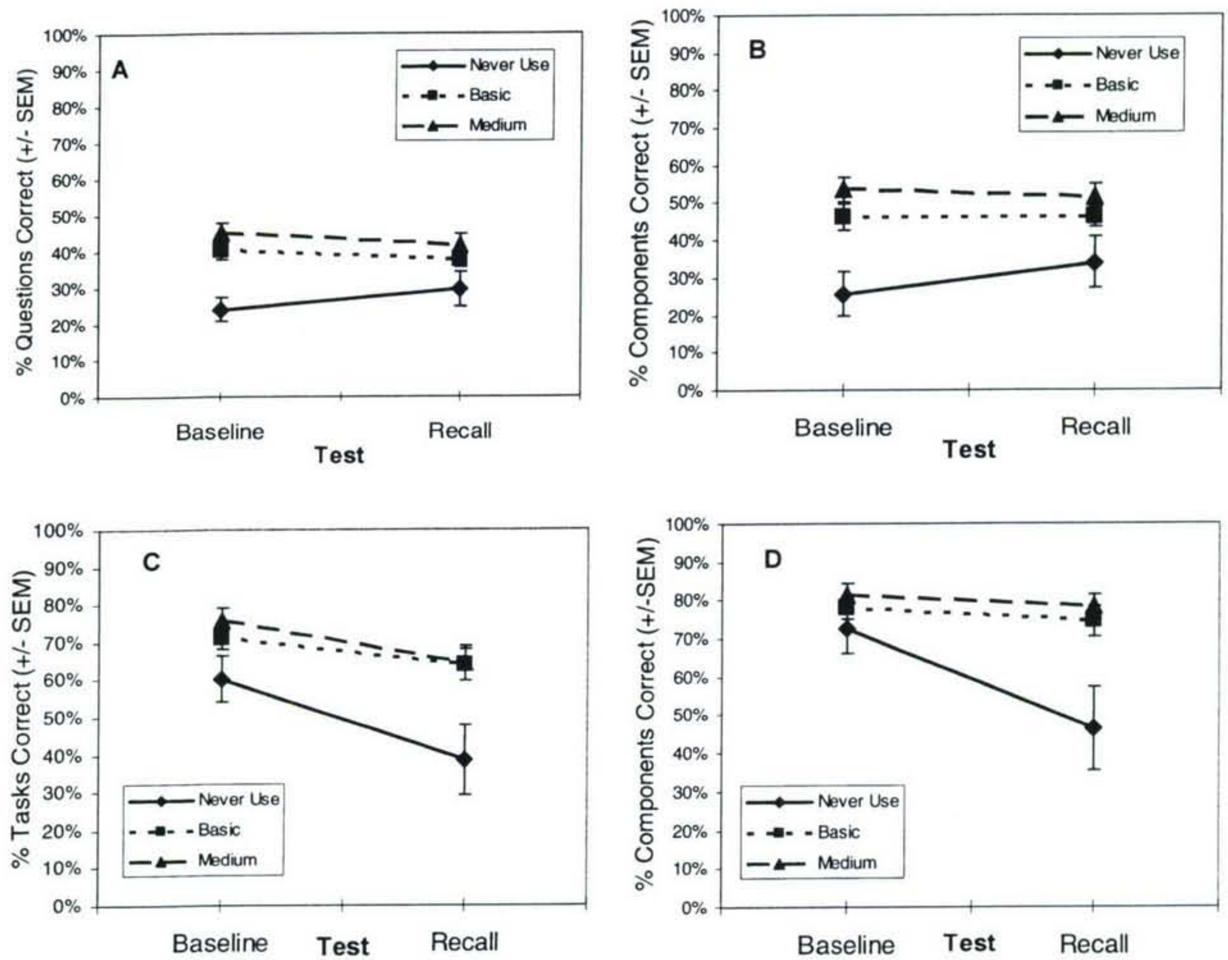

Figure 2. Mean scores on the knowledge and hands-on tests by self-rated proficiency level. Panel A, knowledge test question scores; panel B, knowledge test component scores; panel C, hands-on test task scores; panel D, hands-on test component scores.

There were main effects of test for the hands-on scores but not the knowledge test scores. Both hands-on measures indicated significant decay over the retention interval (hands-on task score, $F[1,51] = 19.7, p < .001$; hands-on component score, $F[1,51] = 10.2, p = .002$, see Figure 2C and 2D). In addition, the analysis of the component scores yielded a significant interaction, $F(2,51) = 3.6, p = .04$. The significant interaction resulted from the fact that only the never-use group exhibited significant decay over the retention interval (see Figure 2D).

As can be seen in this series of ANOVAs, those individuals rating themselves at a basic or medium level of proficiency were indistinguishable on the four outcome measures. Those who had never used FBCB2 before fared significantly worse—showing lower levels of performance across the board, as well as significant forgetting in their component scores for the hands-on test (see Figure 2D).

Discussion

Retention of Digital Operating Skills

Over the eight week retention interval, significant decay occurred in overall performance on the hands-on test but not the knowledge test. More specifically, performance declined significantly on 3 of the 13 hands-on tasks. Although there was no significant change in the overall scores on the knowledge test, the percent of the sample giving correct answers declined significantly on one of the questions and improved significantly on two others.

Predicting performance on the hands-on and knowledge tests was only moderately successful. Pearson correlations between background and experience variables and performance on the knowledge and hands-on tests did not generally yield high correlations. Most variables accounted for 16% to 25% of the variance. Combining all predictors in a regression equation to predict hands-on test performance improved predictability slightly with multiple R^2 accounting for 25% to 32% of the variance.

The greater forgetting of discrete procedural tasks over explicit knowledge is consistent with evidence that declarative knowledge is relatively resistant to decay even after decades (e.g., Bahrick, 1979) whereas discrete procedural skills are highly perishable after only a few weeks (e.g., Schendel et al., 1978). The greater resistance to decay for declarative knowledge seen in the present report has to be considered in light of the fact that baseline performance on the knowledge task was weaker (average score of 40%) than on the hands-on test (average score of 72%). The lower average scores on the knowledge test diminished the potential for decay by creating a floor effect.

The fact that two of the knowledge test items showed significant improvement over the eight week retention interval must also be factored in when considering the apparent decay resistance of explicit knowledge. There are several possible explanations for these unexpected increases in performance the most likely of which is that coincidental learning took place during the retention interval (from classroom activities or discussions with colleagues). Although the participants reported that they had not operated the FBCB2 in the interim, it is reasonable to expect that they would have had opportunities to discuss FBCB2-related topics. The fact that

performance never improved significantly on any of the hands-on tasks, but did improve on two of the nine knowledge test questions, fits well with this hypothesis.

Another possibility is that those items showing improvement reflected a failure of retrieval on the baseline test. The students may have had lower motivation or perhaps were more distracted or stressed on the baseline test than on the recall test. It is also possible that with more time to think about and consolidate the information, participants were better able to retrieve the information during the recall test. Reminiscence is an established phenomenon that improves performance over time (Underwood, 1966), and it is typically associated with verbal materials.

It is important to keep in mind that the questions on the knowledge test were not meant to serve as a diagnostic test for comprehension of the FBCB2 system. Although the knowledge questions were designed by an SME, they were only selected to represent some of the salient topics covered in the two day familiarization training. The relatively low scores on the knowledge test, even at baseline, cannot be interpreted to mean that the participants in this class had a poor understanding of the FBCB2 system. Similarly, high scores would not necessarily indicate that an individual had a strong grasp of the FBCB2 system.

The overall decline in proficiency on the hands-on test in the present research was 10% for the task scores and 5% for the component scores (both declines were statistically significant). By comparison, in the investigation of IVIS skills by Sanders (1999), decay over a 30-day no-training period was considerably larger (23% for message skills and 52% for overlay skills). Although future research will be needed to definitively explain these discrepant results, there were differences between the participants and methodologies that might explain them.

One possible explanation has to do with differences in the system-specific experience of the participants in two experiments. Almost 72% of the sample in the present experiment reported using FBCB2 during deployment in Iraq or Afghanistan. The duration of usage in combat typically ranged from 3-10 months but occasionally reached as high as 15 months. Nearly a third of the individuals rated their FBCB2 proficiency at a medium level. By comparison, none of Sanders' participants reported previous training on IVIS. It may have been that frequent use of FBCB2 during combat deployment enabled the current experiment's participants to form durable memories for specific procedures. It is even possible that participating in the baseline test served to refresh knowledge and skills acquired earlier, yielding a reactivation effect that could benefit performance in the recall test. Indeed, in the present experiment, participants who indicated that they had no prior experience using FBCB2 scored significantly worse on the hands-on test and in the case of the hands-on component score, forgot significantly more than those who rated themselves at a basic or medium level of proficiency.

In a related vein, participants in the current experiment indicated substantial general computer experience. Nearly all individuals (94%) reported using software applications in a Windows environment, and most (81%) had installed application software. In contrast, fewer than half of Sanders' participants (39%) had used a computer for more than a year, and one in four said they did not use a computer at all. The more experienced participants in the present research may have been able to apply their computer skills to some degree when performing FBCB2 tasks. This could have had the effect of counteracting decay effects. Composite

computer experience in this research did correlate significantly with hands-on performance scores. In addition to having less general computer experience, the participants in the Sanders study were all junior enlisted Soldiers (grades E2-E6). Participants in the current experiment were officers (Captains).

Methodological differences between Sanders' investigation and the current experiment may have contributed to apparent differences in findings as well. Sanders limited his hands-on testing to overlay and message skills. On the other hand, the present research tested tasks related to map, message, information management, navigation, and housekeeping functions. No overlay tasks were included, but one of the map tasks—creating a route—is analogous. In terms of measurement, Sanders' primary retention measures were based on a subset of participants who met a performance criterion on the baseline test. When percent correct scores of his entire sample were examined, they showed no significant decay of message skills—the same as found in the present experiment. Regarding map-related tasks, the current research found 20% or greater decline in two map-based skills, which is more in line with Sanders' results for overlay (map-based) skills.

The fact that Sanders used only participants who performed to criterion (i.e., those who demonstrated they were proficient on all tasks tested) may also account for the higher rates of decay observed in that study. Essentially, his participants were trained to criterion so that they were performing at a high level of proficiency at baseline. In the present experiment, all participants received the same training because the goal of the course was only to familiarize them with the system. Statistical regression towards the mean alone would predict greater levels of decay in a group performing at a higher than average level of proficiency than one performing at a lower level.

Another possible explanation relates to the use of the FBCB2 help function. Although participants were allowed to use the system help function during both hands-on tests, they were asked to record their use of the help function only during the recall test. If the self-recording process in the retest encouraged some students to use help, it could have worked against detecting decay effects. This explanation does not seem likely, however, because using help was associated with lower overall performance—in particular, significantly lower recall test scores and non-significantly longer execution times. Thus it seems more likely that using help was a sign of uncertainty about how to perform certain tasks, with assistance from help features failing to improve performance. Nevertheless, it is possible that without the help function, those who used it would have done even worse and the average levels of skill decay would have increased. On balance, closer examination of type of task and type of measure indicates the results of this experiment are more similar to Sanders' findings than it first appears.

A less direct measure of skill decay—the time spent completing the hands-on tasks—also indicated a decline in proficiency. The total time taken to perform all 13 tasks (reading and processing instructions plus executing the steps) increased from an average of 28 min in the baseline test to 35 min in the recall test (25% increase). This measure correlated at low, non-significant levels with accuracy measures of performance (coefficients smaller than .25). Average execution times for each task on the baseline test ranged from 6 sec on the low end to nearly 4 min on the high end, and from 25 sec to more than 5 min on the recall test. There are no

standards to compare these time values against, and the experimenters did not use SMEs to obtain empirically based estimates of expert performance times. It is worth noting that Sanders (1999), following a 30-day decay interval, also found significant increases in performance time for IVIS overlay and report tasks.

A slower rate of executing procedural tasks after a substantial period of non-use is unsurprising, but a faster rate after a decay period has no ready explanation. The significant decrease in execution time occurred for checking the line of sight, where task accuracy scores increased slightly but non-significantly. No participants reported using help for this task in the recall test. Two factors could have been at work to produce the faster rate of execution. First, coincidental learning during the eight-week retention interval may have dealt, in part, with the line of sight function. This is supported by the fact that performance on the knowledge test question regarding the line of sight tool increased significantly in the recall test. Second, prior experience using FBCB2 may have yielded a specific advantage for applying the line of sight function, with the baseline test reactivating the procedural memory.

Predictors of Test Performance

Knowledge and experience. Correlation analyses were used to determine how well knowledge and hands-on test scores could be predicted. In general, baseline and recall test scores correlated significantly and positively with each other for the hands-on and knowledge tests. Weaker, yet still significant, positive correlations also existed across the hands-on and knowledge tests.

Other potential knowledge and experience predictors of performance were examined for both the knowledge and hands-on tests. Somewhat surprisingly, significant predictors of scores on these two types of test showed minimal overlap. Total collective FBCB2 training experiences and self-rated FBCB2 proficiency were the best, although moderate, predictors of performance on the knowledge test. In contrast, composite computer experience was the best predictor of performance on the hands-on test. The total collective training experiences did not correlate significantly with any of the measures of hands-on performance and self-rated FBCB2 proficiency correlated significantly with only the recall component score. Months of use of FBCB2 in combat did not significantly correlate with measures on either the hands-on or knowledge test.

The fact that overall computer experience was the best single, although moderate, predictor of performance on the hands-on test suggests that there is something about experience using personal computers that positively transfers to using FBCB2. The FBCB2 software currently runs on a Unix operating system and the graphic user interface is similar to what is found in Windows or Macintosh systems. Thus there may simply be positive transfer from these systems when learning to use FBCB2. Alternatively, high levels of general computer experience may identify individuals who have an aptitude for learning to use computers. The fact that this measure was a better predictor overall than the total hours of training on FBCB2, the sum of collective FBCB2 training experiences, the months of FBCB2 use in combat and the self-rated FBCB2 proficiency needs to be verified with another sample of Soldiers.

Task characteristics. On the knowledge test, memorizing facts with low meaning or connectedness made for a difficult learning challenge. A good example of hard-to-memorize information was found in the names of the four main areas of the FBCB2's operations screen. These names (classification banner, map area, operations function bar, and FIPR bar) have low intrinsic meaning and don't relate to terminology from a common system such as Microsoft Windows. Recall of these names reached only 22% at the end of the two-day course. Another example was the size limit for messages sent in packet mode, which exhibited 65% decay on average. These findings fit with the literature on verbal learning, where low meaningfulness of the subject material is well known to impede learning (Underwood, 1966).

The number of elements in a question did not relate significantly to performance on the knowledge test. The same was true for the number of steps in a hands-on task. This was somewhat surprising, in light of the literature relating task complexity to digital skill retention (Goodwin, 2006). It is possible that the number of elements or steps did not provide a true index of complexity or a related dimension. It is also possible that other factors, such as chaining of steps or system cuing, overshadowed potential influences of number of steps. It may be also that the experimental design of this investigation did not set robust conditions for illuminating the role of task complexity because task complexity may have diminished performance at both baseline and recall. For example, create a SPOT report, the task with the most steps, was only performed by 22% at baseline and 24% at recall, thus a failure to detect skill decay may have been hindered by a floor effect. In summary, there were very few task characteristics that adequately predicted performance on either the hands-on or knowledge tests.

Looking at the hands-on task components that had greater than 10% change helps to highlight some of the more notable recall problems. In task 3, placing the icon on the map and doing so at a specific location showed 28% and 13% decay, respectively. Ordinarily with GPS, this task would be unnecessary as the system would automatically position the vehicle icon on the map at the correct coordinates. It is possible that, because there was seldom a need to perform this function in theater, it was more easily forgotten. Another factor contributing to decay may be that the first step to placing your own vehicle icon on the map is to press the F6 Admin button, which is less intuitive than the F1 Map button, for example, might be.

Another map component task that showed greater than 10% decay was leaving the route displayed on the map. The steps required to perform this step are not entirely intuitive although the question provided a hint with the phrase "leave the driver's display on." This prompt resembled the checkbox labeled "Driver's display on" that needed to be checked to accomplish this task. Additional research is needed to understand why this was forgotten.

The most common messaging problem stemmed from a quirk of the address book search function. As explained in the *Results* section, typing an addressee in the search field does not always yield an exact match to the right addressee, even when an exact match is in the address book. It is necessary for the user to carefully check the addressee that is returned by the search function before selecting it. Failing to check the addressee was a major contributor to errors on two of the component tasks (creating an address group and setting free text message defaults).

Another feature of this system that may have contributed to errors has to do with the message options for the SPOT report. This dialogue box has two tabs, one to set the message precedence and one to set the message addressee. Clicking on either tab brings it to the foreground and settings can be changed for that tab in a way that is analogous to a Windows system. At the bottom of the message options dialogue box are several buttons visible no matter which tab is in the foreground. Those include "okay", "apply", and "close" buttons. In a Windows system, changes can usually be made to any tabs in any order and then all that is needed to accept those changes is to select "apply" or "okay", but this is not the way it works with FBCB2. The "apply" button must be selected after changes are made to each tab. If changes are made to one tab and then another is selected before clicking "apply", all the changes made to the tab will revert to their default settings. It is possible that the large number of errors related to setting the precedence for the SPOT report is due to this idiosyncrasy.

Next to sending a SPOT report, clearing logs and queues was performed by the lowest percentage of individuals on the baseline test and had the lowest rate of all tasks on the recall test. This task had only five steps but screen prompts for this task are largely missing. Performing this task required the user to first choose the "Start" button in the lower left corner of the screen, then "FBCB2" and then "Clear logs and queues", followed by selecting items to clear and then selecting the "Apply" button.

Techniques for Counteracting Decay

The results of the present experiment point to some ways current trainers might improve training and retention for FBCB2 operator skills. First, because we found significant effects of self-rated proficiency on learning and recall, it could be beneficial to identify those individuals who have had no prior exposure to FBCB2 for some remedial training. Those individuals indicating they had never used FBCB2 learned less and forgot it faster than those who gave themselves low or medium self-ratings of proficiency.

Accommodating experience and proficiency differences in a single group of students can be challenging, but doing so is important for getting everyone to a higher level of proficiency (Leibrecht, Wampler, Goodwin, & Dyer, in preparation; Wampler et al., 2006). Those with no previous exposure to the system may be especially motivated to learn, a factor upon which instructors can capitalize. As Leibrecht et al. (in preparation) noted, the digitally savvy students can buddy with less experienced colleagues to serve as demonstrators and discussion group participants. The inexperienced students can be encouraged to seek help from the instructors or peer coaches, both during and after a training session.

It was also clear that some topics and tasks were easily forgotten by the students. Thus, developing mnemonics or other memory aids—or perhaps reallocating time to focus on some of the more easily forgotten topics and tasks—could help counteract their tendency to be forgotten. For example, instructors might develop mnemonics for the names of the two main FBCB2 screens, the largest allowable message size, the four main areas of the operations screen, and the advantages of FBCB2 and BFT. Similarly, greater emphasis needs to be given to helping students to remember the steps for clearing logs and queues, creating a SPOT report, selecting addressees using the search function, and manually placing their icon on the map.

Still other training emphasis might be added to the use of the FBCB2 help function. As reported above, use of the help system was associated with lower success on the hands-on tasks. Although this most likely indicates that those using the help function were least knowledgeable about the system, one might expect that the help function would have been more effective at compensating for those deficiencies.

Lessons Learned

Because the participants were taking time out of the Captain's Career Course to participate in this data collection effort, it was important to keep the time and scheduling complexity to a minimum by testing all participants simultaneously. This constraint required us to make some trade-offs so that we could collect a large amount of data in a short period of time.

One trade-off was our limited ability to measure and evaluate process during the hands-on test. In other words, we could not record each individual menu choice or movement of the pointing device, a constraint that reduced our ability to understand some of the sources of error leading to forgetting. For example, to determine whether participants successfully cleared logs and queues, a message was sent to all systems prior to the test. Participants who successfully cleared logs and queues eliminated the message. This allowed us to assign a go/no-go to each student for that task, but it did not allow us to determine exactly which step of that task was most likely to be forgotten. On most of the other tasks, however, there were multiple footprints left on the system that did allow us to more precisely pinpoint the source of error. For example for the task "create, save, and send a SPOT report" there were 12 separate items that could be confirmed on each workstation.

We feel that accepting this trade-off was reasonable for a couple of reasons. First of all, by choosing a series of relatively basic tasks for the hands-on test, it was always possible to narrow the source of errors down to a few steps. Even for a task like clearing logs and queues, which had only five steps, we can safely assume that the error probably occurred somewhere among the first two steps as the last three steps involved selecting "apply", "close", and "close." It is hard to imagine that someone who got past the first two steps would have been unable to complete the last three. Secondly, we never viewed this research effort as providing the final answers to all questions about the decay of FBCB2 skills. Instead, we realized that it would help us to focus future research efforts and in that regard it has been successful.

Another trade-off was choosing to observe a sample of convenience. The ICCC students only received two days of orientation training. The training was intended to familiarize new users with the system's capabilities and to provide some refresher training to individuals with prior experience on the system. There was no proficiency requirement for this course and as a result, baseline proficiency measures were less than perfect, sometimes substantially so. The primary disadvantage of using this sample was that it was not optimal for tracking skill decay. Nevertheless, this trade-off was deemed acceptable because we wanted to test our design and data collection techniques on a readily available sample before going to the expense of a larger scale data collection effort with a sample that would be considerably more difficult to track for a retention test. Furthermore, it could be argued that the proficiency levels of this sample may

more closely resemble those observed in a typical unit (i.e., it's unlikely that any unit ever has proficiency in 100% of its members) and so in that regard these skill decay data provide insight into the rate of decay that might be expected in actual units.

Using participants' self-reported start and stop times and use of the help system was another trade-off that allowed us to perform the data collection *en masse* Based on the results, it appears that very few participants recorded obviously flawed times suggesting this was an acceptable means of recording this measure. The accuracy with which participants recorded their own use of the help system is more difficult to assess. Half of all participants reported using the help function at least once and every effort was made by the experimenters to indicate that using the help function was acceptable.

The fact that we only asked participants to record their use of help on the recall test may have produced a minor confounding in our results. There may have been an implicit assumption by many of the participants that using help was not allowed during the baseline test since no instructions were given regarding its use. If more participants used help during the recall test as a result of being asked to indicate when they did so, this may have inflated retention scores. Arguing against this possibility is the fact that those who used help at least once did significantly worse on the recall test than those who did not. Still, in future studies, using the help function should be recorded during all hands-on test sessions.

Conclusions

For the FBCB2 skills investigated in this report, significant decay was observed over an eight week retention interval. The good news is that overall performance declined by only 10%. In fact, there was significant decay on only three of the 13 tasks, each with 19-24% decrement. When looking at the components of those tasks, it appears that most of the decay was associated with forgetting how to place an icon on the map, forgetting how to leave a route displayed, and forgetting how to assign the correct addressee. The elapsed time measure appears to be a more sensitive measure of decay, showing significant skill decline on eight of the 13 tasks and improvement for one task.

Understanding the causes of the decay on these tasks is still speculative, but it is unlikely that a single factor accounts for all forgetting. The background experience and training of individuals contributes to decay, predicting about 25-35% of performance variability. Vague or absent screen prompts, system idiosyncrasies, and an inability to use the system help effectively also account for some decay, but a precise number can't be attributed to those factors just yet.

These findings identify potentially vulnerable FBCB2 skills and suggest that trainers may want to devote additional instructional time or emphasis to these topics. It is important to keep in mind that this is the first empirical analysis of FBCB2 skill decay. Future studies will need to be done to confirm these results before a strong recommendation can be made to alter training approaches or programs of instruction. Furthermore, future research on FBCB2 skill decay should include a wider range of tasks that represent operational uses of the system, and should focus on understanding the exact causes of forgetting. This will help system designers and

training developers to make informed decisions about how to modify the system and the way Soldiers should train to use it.

References

Adams, J. A. (1987). Historical review and appraisal of research on the learning, retention, and transfer of human motor skills. *Psychological Bulletin, 101*(1), 41-74.

Bahrick, H. P. (1979). Maintenance of knowledge: Questions about memory we forgot to ask. *Journal of Experimental Psychology: General, 108*(3), 296-308.

Clark, J. E. (2005). *Solving a command and control system education and training dilemma for the modular force* (A white paper). Washington, DC: Army Joint Support Team.

Goodwin, G. A. (2006). *The training, retention, and assessment of digital skills: A review and integration of the literature* (ARI Research Report 1864). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Johnston, J. C., Leibrecht, B. C., Holder, L. D., Coffey, R. S., & Quinkert, K. A. (2002). *Training for future operations: Digital leaders' transformation insights* (ARI Special Report 53). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A412717)

Leibrecht, B. C., Wampler, R. L., Goodwin, G. A., & Dyer, J. L. (in preparation). *Training digital operator skills in the classroom: Contemporary techniques and practices* (ARI Research Report). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Lynch, R. P. (2001). *Lessons learned: Commanding a digital brigade combat team* (IDA Paper P-3616). Alexandria, VA: Institute for Defense Analysis-Joint Advanced Warfighting Program. (DTIC No. AD-A395042)

McNemar, Q. (1975). *Psychological statistics* (5th Ed.). New York: Wiley.

Sanders, W. R. (1999). *Digital procedural skill retention for selected M1A2 tank inter-vehicular information system (IVIS) tasks* (ARI Technical Report 1096). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A368212)

Schaab, B. B., & Moses, F. L. (2001). *Six myths about digital skills training* (ARI Research Report 1774). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A392922)

Schendel, J. D., Shields, J. L., & Katz, M. S. (1978). *Retention of motor skills. Review* (ARI Technical Paper 313). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A061338)

Seacord, C. R. (2000). *Digitizing the battlefield* (U.S. Army War College). Carlisle Barracks, PA: U.S. Army War College. (DTIC No. AD-A377740)

Underwood, B. J. (1966). *Experimental psychology*. New York: Appleton-Century-Crofts.

U.S. Army Armor Center (1996). *Advanced warfighter experiment Focused Dispatch final report*. Fort Knox, KY: U.S. Army Armor Center, Mounted Battlespace Battle Lab.

Wampler, R. L., Dyer, J. L., Livingston, S. C., Blankenbeckler, P. N., Centric, J. H., & Dlubac, M. D. (2006). *Training lessons learned and confirmed from military training research* (ARI Research Report 1850). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A446697)

APPENDIX A

ACRONYMS

ABCS	Army Battle Command System
AFATDS	Advanced Field Artillery Tactical Data System
ANOVA	analysis of variance
AS3	Assistant Operations Officer
ASAS	All Source Analysis System
BFT	Blue Force Tracking
BIOS	Basic Input and Output System
C3	computerized command and control
CPX	command post exercise
CTC	combat training center
FBCB2	Force XXI Battle Command Brigade and Below
FDO	fire direction officer
FIPR	flash, immediate, priority, routine
FSO	fire support officer
FTX	field training exercise
GPS	Global Positioning System
ICCC	Infantry Captains Career Course
IVIS	Inter-Vehicular Information System
KB	kilobyte
LOS	line of sight
MCS	Maneuver Control System
NAV	navigation
NET	new equipment training
OA	operator acknowledgment
OBC	Officer Basic Course
S3	operations officer
S6	information management officer
SA	situational awareness
SEM	standard error of the mean
SME	subject matter expert
TOC	tactical operations center
TRADOC	U.S. Army Training and Doctrine Command

APPENDIX B

KNOWLEDGE AND HANDS-ON MEASUREMENT INSTRUMENTS

FBCB2 Training and Experience
Baseline Measurement

The purpose of this research project is to understand which FBCB2 knowledge and skills are most quickly forgotten and therefore are in need of improved initial and/or sustainment training. In addition to this baseline measurement, you will take part in an 8-week follow up assessment.

Your responses to all questions are used for research purposes only and will be kept confidential. Nobody will have access to them outside of the research team and your score will not impact your standing in the ICCC course.

So that we can compare your responses now and at 8 weeks, please provide your last name and first initial.

Last Name, First Initial

PRIVACY ACT STATEMENT

Public Law 93-573, called the Privacy Act of 1975, requires that you be informed of the purpose and uses to be made of the information collected.

The Department of the Army may collect the information requested in this survey under the authority of 10 United States Code 2358. Providing information is voluntary. Failure to respond to any particular questions will not result in any penalty.

The information collected in the survey will be used solely for research purposes. Your responses will be held in strict confidence. No one outside the research team will have access to individual data.

Do Not Turn This Page Until Told To Do So

Experience and Training History with Army Battle Command Systems

1. **Prior to attending ICCC**, tell us **how many hours** and the **date** of your **individual system operator training** for each of the digital systems listed below.

Training		FBCB2	ASAS	MCS	AFATDS
No Operator Training (check)		☐	☐	☐	☐
Online Course	Hours				
	Date(year)				
Trained in OBC	Hours				
	Date(year)				
NET Training	Hours				
	Date(year)				
NET Delta Training (trained on changes and upgrades)	Hours				
	Date(year)				
Digital Master Trainer Course	Hours				
	Date(year)				
Other:________________	Hours				
	Date(year)				

2. Indicate the types of **collective unit training** you have had with the following systems, **prior to attending ICCC. Place an "X" in all appropriate boxes.**

	FBCB2	ASAS	MCS	AFATDS
No collective unit training Received				
Company or Platoon Motorpool training				
Company or Platoon FTX at home station				
Company or Platoon FTX at a CTC				
CPX training in a digital training facility				
CPX training at home station				
CPX training at a CTC				
Other:				

Next Page

3. Have you ever used any digital systems while deployed on a **combat tour**? ☐YES ☐NO

If you answered YES, complete the table below. If you answered NO go on to question 4.

System and Version	Combat Theater	Duty position when using this system	Number of months you used this system in theater

4. Overall how would you **rate your proficiency** on each system?

Basic – You can use the system to perform a limited set of functions but there are many aspects of the system with which you are unfamiliar.

Medium – You are comfortable with the system and are knowledgeable about most of its functions and quirks. You have limited troubleshooting abilities.

High – You have advanced knowledge of this system and can troubleshoot many problems. You frequently are asked to help others who have difficulty with the system.

Check the appropriate boxes:

System	Never Used	Basic	Medium	High
FBCB2	☐	☐	☐	☐
ASAS	☐	☐	☐	☐
MCS	☐	☐	☐	☐
AFATDS	☐	☐	☐	☐

Next Page

5. Indicate the type of experience you have using the following operating systems (check all that apply):

Task	Windows	Mac OS	Linux
Never Used this operating system	☐	☐	☐
Used application software (e.g., Outlook, PowerPoint, games)	☐	☐	☐
Installed application software	☐	☐	☐
Installed software patches	☐	☐	☐
Installed Hardware (e.g., hard drive, graphics card)	☐	☐	☐
Changed boot-up options	☐	☐	☐
Changed BIOS settings	☐	☐	☐
Authored web pages using software on this system	☐	☐	☐
Authored programs for this operating system	☐	☐	☐

FBCB2 Training and Experience
Recall Measurement

1. Have you operated FBCB2 for any reason since the baseline test we administered on 24 May?
   (Circle one): YES NO

If you answered NO, Proceed to the next page.

2. If you answered YES, estimate the total time (in hours) you have used FBCB2 since taking the baseline test on 24 May.

   Estimate of hours: ________

FBCB2 KNOWLEDGE TEST
BASELINE AND RECALL MEASUREMENTS

INSTRUCTIONS: Complete the following questions to the best of your ability.

1. What does FBCB2 stand for?

2. What does the acronym FIPR stand for?
    a. F: __________
    b. I: __________
    c. P: __________
    d. R: __________

3. Name the 2 screens on the FBCB2 system.
    a. __________
    b. __________

4. What are the four main areas of the Operations screen?

a.____________________
b.____________________
c.____________________
d.____________________

5. The largest message size sent in Packet Mode on FBCB2 is _________ bytes.
    a. 576
    b. 800
    c. 1450
    d. 1280

6. What is meant by a "Near Real Time Update"? ____________________________________

7. Besides the dead space, the Line of Sight Tool allows the Soldier to quickly determine the __________________ and ____________________, between two points selected on the map screen.

8. If your system is running unusually slow, what can you do to speed it up? ___________

9. List one advantage of FBCB2-Terrestrial and FBCB2-BFT

FBCB2-Terrestrial: ____

FBCB2-BFT: ____

10. When assigning a periodic reminder, which time zone must you enter the time in?

____

HANDS-ON TEST – FBCB2 OPERATOR TASKS
BASELINE MEASUREMENT

INSTRUCTIONS:

Using the FBCB2 system, execute the 13 FBCB2 operator tasks on the following pages to the best of your ability. If you cannot complete any task, indicate that you could not perform the task and move on to the next task. Proctors and Instructors will not assist you in answering any of the questions.

For each of the 13 tasks, do the following:

1. READ THE TASK.

2. RECORD YOUR START TIME. Record the exact time in terms of hour, minute, and seconds. (e.g., 11:33:21)

3. RECORD THE STOP TIME FOR THE TASK YOU JUST COMPLETED.

4. CONTINUE WITH THE NEXT TASK.

Once you have completed all tasks raise your hand and someone will come by and check your sheets and release you. Thank you for your cooperation and assistance in this research effort.

PROCEED AT YOUR OWN PACE.

Next Page

BE SURE TO RECORD
YOUR START
AND
STOP
TIMES!!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 1. What is the **role** your computer is set to?

Task 1 START TIME _____:_____:_____
(hh) (mm) (ss)

Enter the role here____________________.

Task 1 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Task 2. Clear ALL your logs and queues and ensure your map is displayed for operations.

Task 2 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 2 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Task 3. Position your icon at grid loc vic **14RPV 21184 50414**.

Task 3 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 3 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Task 4. Set your SA settings to Stale: 12 hours; Old: 24 hours; and Purge: 48 hours.

Task 4 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 4 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Next page

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 5. Create two message folders. Name one '**companymessages**' and the other '**companyoverlays**'.

Task 5 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 5 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Task 6. Create an address group named TOC. The TOC address you will use is **cdr-bde4-3id**.

Task 6 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 6 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Task 7. Create a default message address for free text messages. Precedence is **immediate**, acknowledge is **operator acknowledge**, and the unit address you are sending the message to is **cdr-bde4-3id**.

Task 7 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 7 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Next Page

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 8. Create and send a free text message with the subject line as READY. Text should read as follows: IN POSITION AND READY TO EXECUTE MISSION. Set precedence to **priority** and send it to the **TOC address group**.

Task 8 START TIME ______:_____:_____
(hh) (mm) (ss)

Task 8 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Task 9. Create, Save, and send a SPOT report to the Brigade Commander, 4th Bde, 3d ID. You have just spotted an **armored personnel carrier** and **8 dismounted personnel**, at grid location **14RPV 18515 49816.** The affiliation for the target is **suspect**, and it is **assembling**. Precedence should be set to **Immediate** and acknowledgement set to **OA**. Save the message as **SPOT1**. Send the message.

Task 9 START TIME ______:_____:_____
(hh) (mm) (ss)

Task 9 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Task 10. Display and save a message. You have received a message from the CDR 4th Brigade. Display the message, save it as **MOVE1**, and save it in **companymessages.**

Task 10 START TIME ______:_____:_____
(hh) (mm) (ss)

Task 10 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Next Page

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 11. Create a route with 5 waypoints – the first should be the start point (SP) which is your **present location**. The last waypoint should be the release point (RP). Name the route **ROUTE0001**. Use the map to select your waypoints. Be sure to **leave the driver display ON**.

Task 11 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 11 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Task 12. Auto center your icon.

Task 12 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 12 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Task 13. Create a line of sight (LOS) from your own location to 14RPV 18514 49839. Set the height above ground as **2 meters**.

LEAVE THE LOS WINDOW DISPLAYED.

Task 13 START TIME _____:_____:_____
(hh) (mm) (ss)

Task 13 STOP TIME _____:_____:_____
(hh) (mm) (ss)

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

You have completed the test. Raise your hand and a proctor will check your test and release you.

HANDS-ON TEST – FBCB2 OPERATOR TASKS
RECALL MEASUREMENT

INSTRUCTIONS:

Using the FBCB2 system, execute the 13 FBCB2 operator tasks on the following pages to the best of your ability. If you cannot complete any task, indicate that you could not perform the task and move on to the next task. Proctors and Instructors will not assist you in answering any of the questions.

For each of the 13 tasks, do the following:

1. **READ THE TASK.**
2. **RECORD YOUR START TIME.** Record the exact time in terms of hour, minute, and seconds. (e.g., 11:33:21)
3. **RECORD THE STOP TIME FOR THE TASK YOU JUST COMPLETED.**
4. **CONTINUE WITH THE NEXT TASK.**
5. **If you do NOT KNOW HOW to complete a task, write in the area for that task, "UNABLE TO COMPLETE" and move on to the next task.**
6. **If you used the Help for that task, please indicate so by checking the appropriate box for each question.**

Once you have completed all tasks raise your hand and someone will come by and check your sheets and release you. Thank you for your cooperation and assistance in this research effort.

PROCEED AT YOUR OWN PACE.

Next Page

BE SURE TO RECORD
YOUR START
AND
STOP TIMES!!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 1. What is the **role** your computer is set to?

Task 1 START TIME ______:_____:_____
(hh) *(mm)* *(ss)*

Enter the role here_________________________.

Did you use the help function? Yes ☐ No ☐

Task 1 STOP TIME ______:_____:_____
(hh) *(mm)* *(ss)*

Task 2. **Clear ALL your logs and queues and ensure your map is displayed for operations.**

Task 2 START TIME ______:_____:_____
(hh) *(mm)* *(ss)*

Did you use the help function? Yes ☐ No ☐

Task 2 STOP TIME ______:_____:_____
(hh) *(mm)* *(ss)*

Task 3. **Position your icon** at grid loc vic **14RPV 20397 48244**.

Task 3 START TIME ______:_____:_____
(hh) *(mm)* *(ss)*

Did you use the help function? Yes ☐ No ☐

Task 3 STOP TIME ______:_____:_____
(hh) *(mm)* *(ss)*

Next page

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 4. Set your SA settings to Stale: 6 hours; Old: 12 hours; and Purge: 36 hours.

Task 4 START TIME ______:_____:_____
(hh) (mm) (ss)

Did you use the help function? Yes ☐ No ☐

Task 4 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Task 5. Create two message folders. Name one '**unitmessages**' and the other '**unitoverlays**'.

Task 5 START TIME ______:_____:_____
(hh) (mm) (ss)

Did you use the help function? Yes ☐ No ☐

Task 5 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Task 6. Create an address group named TOC. The TOC address you will use is **cdr-bde1-3id**.

Task 6 START TIME ______:_____:_____
(hh) (mm) (ss)

Did you use the help function? Yes ☐ No ☐

Task 6 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Next Page

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 7. Create a default message address for free text messages. Precedence is **immediate**, acknowledge is **operator acknowledge**, and the unit address you are sending the message to is **cdr-bde1-3id**.

Task 7 START TIME _____:_____:_____
(hh) (mm) (ss)

Did you use the help function? Yes ☐ No ☐

Task 7 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Task 8. Create and send a free text message with the subject line as PROBLEM. Text should read as follows: B26 HAS LOST POWER. Set precedence to **priority** and send it to the **TOC address group**.

Task 8 START TIME _____:_____:_____
(hh) (mm) (ss)

Did you use the help function? Yes ☐ No ☐

Task 8 STOP TIME _____:_____:_____
(hh) (mm) (ss)

Next Page

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 9. Create, Save, and send a SPOT report to the Brigade Commander, 1st Bde, 3d ID. You have just spotted **three attack helicopters**, one with **6 anti-tank missiles**, at grid location **14RPV 1652 5053.** The affiliation for the target is **hostile**, and it is **reconnoitering**. They are moving at **medium** speed, heading **southeast**. Precedence should be set to **Immediate**, and acknowledgement set to **OA**. Save the message as **SPOT6**. Send the message.

Task 9 START TIME ______:_____:_____
(hh) (mm) (ss)

Did you use the help function? Yes ☐ No ☐

Task 9 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Task 10. Display and save a message. You have received a message from the CDR 1st Brigade. Display the message, save it as **MOVE4**, and save it in **unitmessages.**

Task 10 START TIME ______:_____:_____
(hh) (mm) (ss)

Did you use the help function? Yes ☐ No ☐

Task 10 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Task 11. Create a route with 5 waypoints – the first should be the start point (SP) which is your **present location**. The last waypoint should be the release point (RP). Name the route **ROUTEPUMA**. Use the map to select your waypoints. Be sure to **leave the driver display ON**.

Task 11 START TIME ______:_____:_____
(hh) (mm) (ss)

Did you use the help function? Yes ☐ No ☐

Task 11 STOP TIME ______:_____:_____
(hh) (mm) (ss)

Next Page

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

BE SURE TO RECORD YOUR START AND STOP TIMES!!!

Task 12. Auto center your icon.

Task 12 START TIME _____:_____:_____
(*hh*) (*mm*) (*ss*)

Did you use the help function? Yes ☐ No ☐

Task 12 STOP TIME _____:_____:_____
(*hh*) (*mm*) (*ss*)

Task 13. Create a line of Sight (LOS) from the last location you sighted the enemy helicopters to your location. Set the height above ground as **50 meters**.

LEAVE THE LOS WINDOW DISPLAYED.

Task 13 START TIME _____:_____:_____
(*hh*) (*mm*) (*ss*)

Did you use the help function? Yes ☐ No ☐

Task 13 STOP TIME _____:_____:_____
(*hh*) (*mm*) (*ss*)

You have completed the test. Raise your hand and a proctor will check your test and release you.

APPENDIX C

SCORING MATERIALS FOR KNOWLEDGE AND HANDS-ON TESTS

FBCB2 Knowledge Test – Scoring Rules

NOTE-1: Ignore spelling errors and transposition errors throughout.

NOTE-2: Ignore student indications of guessing when answer is correct.

1. What does FBCB2 stand for? (Force XXI Battle Command Brigade & Below)

Range of Scores: 0-5; credit one point for each correct element (Force XXI – Battle – Command – Brigade – & Below) regardless of sequence; "Force" without "XXI" is OK; ignore extra words unless they clearly indicate guessing (e.g., Future Force).

2. What does the acronym FIPR stand for?
   a. F: __________(Flash)
   b. I: __________(Immediate)
   c. P: __________(Priority)
   d. R: __________(Routine)

Range of Scores: 0-4; credit one point for each correct item, regardless of sequence; ignore extra words unless they clearly indicate guessing (e.g., Instant Immediate).

3. Name the 2 screens on the FBCB2 system.
   a. __________(Session Manager Screen *or* Session *or* Manager *or* Admin Screen)
   b. __________(OPS Screen *or* Operations Screen *or* Ops *or* Operation *or* Operating Screen)

Range of Scores: 0-2; credit one point for each correct item; ignore extra words unless they clearly indicate guessing.

4. What are the four main areas of the Operations screen?
   a. __________ (Classification banner *or* Classification bar *or* Classification)
   b. __________ (SA/Map Area *or* SA *or* Map *or* SA area *or* Map area *or* Situation Awareness)
   c. __________ (Ops function bar *or* Ops bar *or* Ops function *or* Functions bar *or* Operations bar)
   d. __________ (Com Status/FIPR bar *or* Com Status *or* FIPR *or* FIPR/Com *or* FIPR Status)

Range of Scores: 0-4; credit one point for each correct item, regardless of sequence; ignore extra words unless they clearly indicate guessing.

5. The largest message size sent in Packet Mode on FBCB2 is _________ bytes. (C)
   a. 576
   b. 800
   c. <u>1450</u>
   d. 1280

Range of Scores: 0-1; one point if answer is correct; if two or more answers are circled, score = 0.

6. What is meant by a "Near Real Time Update"? ***** Suspend this question from scoring *****

____

(Network/bandwidth limitations delay transmission; *or* SA icons may be inaccurate; *or* transmission of location information is delayed; *or* update is triggered by time or movement criteria)

Range of Scores: Not Applicable

7. Besides the dead space, the Line of Sight Tool allows the Soldier to quickly determine the ________________ and ________________, between two points selected on the map screen.
(azimuth/bearing/heading/direction) (distance/range/meters) (elevation)

Range of Scores: 0-2; credit one point for each correct item, regardless of sequence; ignore extra words unless they clearly indicate guessing.

8. If your system is running unusually slow, what can you do to speed it up?
____(Clear Logs & Queues *or* Delete messages/overlays/files/data *or* Clean out folders *or* Free up space *or* Reset system)

Range of Scores: 0-1; credit one point if answer suggests correct understanding; if answer merely discusses speed, score = 0.

9. List one advantage of FBCB2-Terrestrial and FBCB2-BFT

FBCB2-Terrestrial:____
(Larger bandwidth *or* shows individual vehicles *or* secure network)
FBCB2 – BFT ____
(Terrain does not impede signal *or* Satellite link overcomes LOS limit *or* Relay is unnecessary)

Range of Scores: 0-2; credit one point for each answer that conveys correct understanding; ignore extra verbiage as long as correct answer is present; if answer states operating principle but no advantage, score = 0.

10. When assigning a periodic reminder, which time zone must you enter the time in? ________
(ZULU *or* GMT *or* Greenwich Mean Time)

Range of Scores: 0-1; one point for correct answer; ignore extra words unless they clearly indicate guessing.

Baseline Hands-on Data Collection Instrument

Name of person being graded:____________________________________

Name of data collector:____________________________________

Task 13. LOS

A. Is the line of sight profile showing? Yes No
B. Is the distance above ground set to 2 meters? Yes No
C. Comments (if any items are "NO" copy student's response below)

Range of Scores: 0-2; one point for each Yes; ignore comments.

Task 1. Role

A. Is the role recorded correctly? Yes No
B. Comments (if any items are "NO" copy student's response below)

Range of Scores: 0-1; one point if 1a is Yes; one point if 1a is No *and* student response is a close approximation of the correct role.

Task 3. Position Icon on the Map

A. Is the icon on the map? Yes No
B. Click on the role to see location
Is the icon located precisely at 14 RPV 21184 50414? Yes No
C. Comments (if any items are "NO" copy student's response below)

Range of Scores: 0-2; one point for each Yes; one point if 3b is No *and* recorded coordinates show evidence of typo(s).

Task 2. Clear All Logs and Queues

A. Check the FIPR Queue – is there more than one message? Yes No
Open F4 Messages – go to the Sent Queue
B. Are any of the messages older than the start time of the test? Yes No
C. Are there any other directories present? [originally 5c] Yes No
D. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-3; one point if 2a is Yes; "missing data" if 2a is No *and* FIPR queue contains zero messages; one point if 2b is No; one point if 2c is No.

Task 4. SA Settings

Click F6 Admin. Select the SA Tab and Friendly

A. Is Stale set to 12 hrs? Yes No
B. Is Old set to 24 hours? Yes No
C. Is Purge set to 48 hours? Yes No
D. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-3; one point for each Yes; if "correct" values result from failure to clear logs and queues, score = 0; if elapsed time is zero, score = 0.

Task 5. Create Message and Overlay folders

Click F4 Messages. Select the Manage Tab.

A. Is there a directory named companymessages? Yes No
B. Is there a directory named companyoverlays? Yes No
C. Comments (if any items are "NO" copy student's response below)

Range of Scores: 0-2; one point if 5a is Yes, one point if 5b is Yes; if the target directory names ("companymessages" and "companyoverlays") are missing but close approximations are found, award one point for each (two points possible).

Task 6. Create an Address Group Named TOC

F4 Messages. Select the Create Tab. Select Edit Address Groups.

A. Is there a message address group called TOC? Yes No
B. Is the addressee cdr-bde1-3id (4B)? Yes No
C. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-2; one point for each Yes; ignore comments.

Task 7. Set the free text message default address

Select Create tab. Highlight 'free text message". Select Message Addressing.

A. Is the addressee cdr-bde1-3id? Yes No
B. Is the precedence set to *immediate*? Yes No
C. Is the acknowledgement set to *operator acknowledge*? Yes No
D. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-3; one point for each Yes; ignore comments.

Task 8. Create and Send a Free text message

Select Sent Queue tab. Highlight the free text message. Select Execute.

A. Was the free text message sent? Yes No

B. Is the addressee the TOC address group? Yes No

C. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-2; one point for each Yes; one point if 8b is No *and* address matches the TOC address created in Task 6.

Task 9. Create, save, and send a SPOT report.

Select the Edit tab. Expand companymessages and select SPOT1. Click on Execute.

Scroll down to view message.

A. Was there a message named SPOT1 in companymessages? Yes No

B. Did the message indicate an APC? Yes No

C. Did the message indicate the location 14RPV185 498? Yes No

D. Did the message indicate they were suspect? Yes No

E. Did the message indicate they were assembling? Yes No

F. Did the message indicate there were 8 dismounts? Yes No

G. Was the precedence set to *immediate*? Yes No

H. Check the Sent Queue – did it indicate that SPOT1 was sent? Yes No

I. Is the addressee cdr-bde1-3id (4B)? Yes No

J. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-10; one point if any Spot report is found in "companymessages" folder or in "combat messages" folder; one point if report name is "SPOT1"; one point for each Yes in 9b thru 9i.

Task 10. Display and save a message.

Select the Manage tab. Expand companymessages.

A. Is there a message saved that is named MOVE1? Yes No

B. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-1; one point if 10a is Yes; one point if 10a is No *and* report name is a variation of MOVE1.

NOTE – Close F4 Messages when this task is completed.

Task 11. Create a Route with 5 waypoints.

Select NAV. Select the down arrow and locate ROUTE0001. Select it.

A. Is the route displayed on the map? Yes No

A. Is the route name ROUTE0001? Yes No

B. Indicate the number of waypoints in the route

____

C. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-3; one point if 11a is Yes; one point if 11b is Yes; one point if 11c is 5.

Task 12. Center Icon on Map

A. Is the blue filled icon in the center of the map sheet? Yes No

B. Is the AutoCenter off? Yes No

C. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-1; one point if 12a is Yes; exclude 12b from scoring.

NOTE-1: Ignore errors (especially spelling and transposition) in students' handwritten responses.

NOTE-2: If a clear answer cannot be determined for an item, treat it as a missing data point.

Recall Hands-on Data Collection Instrument

Name of person being graded:_______________________________________

Name of data collector:_______________________________________

Task 13. LOS

- **D. Is the line of sight profile showing? Yes No**
- **E. Is the distance above ground set to 50 meters? Yes No**
- **F. Comments (if any items are "NO" copy student's response below)**

Range of Scores: 0-2; one point for each Yes; ignore comments.

Task 1. Role

- **A. Is the role recorded correctly? Yes No**
- **B. Comments (if any items are "NO" copy student's response below)**

Range of Scores: 0-1; one point if 1a is Yes; one point if 1a is No *and* student response is a close approximation of the correct role.

Task 3. Position Icon on the Map

- **A. Is the icon on the map? Yes No**
- **B. Click on the role to see location**
  Is the icon located precisely at 14 RPV 20397 48244? Yes No
- **C. Comments (if any items are "NO" copy student's response below)**

Range of Scores: 0-2; one point for each Yes; one point if 3b is No *and* recorded coordinates show evidence of typo(s).

Task 2. Clear All Logs and Queues

- **A. Check the FIPR Queue – is there only one message? Yes No**
  Open F4 Messages – go to the Sent Queue
- **B. Are any of the messages older than the start time of the test? Yes No**
- **C. Are there any other directories present? [originally 5c] Yes No**
- **D. Comments: (if any items are "NO" copy student's response below)**

Range of Scores: 0-3; one point if 2a is Yes; "missing data" if 2a is No *and* FIPR queue contains zero messages; one point if 2b is No; one point if 2c is No.

Task 4. SA Settings

Click F6 Admin. Select the SA Tab and Friendly

A. Is Stale set to 6 hrs? Yes No

B. Is Old set to 12 hours? Yes No

C. Is Purge set to 36 hours? Yes No

D. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-3; one point for each Yes; if "correct" values result from failure to clear logs and queues, score = 0; if elapsed time is zero, score = 0.

Task 5. Create Message and Overlay folders

Click F4 Messages. Select the Manage Tab.

A. Is there a directory named unitmessages? Yes No

B. Is there a directory named unitoverlays? Yes No

C. Comments (if any items are "NO" copy student's response below)

Range of Scores: 0-2; one point if 5a is Yes, one point if 5b is Yes; if the target directory names ("unitmessages" and "unitoverlays") are missing but close approximations are found, award one point for each (two points possible).

Task 6. Create an Address Group Name TOC

Click F4 Messages. Select the Create Tab. Select Edit Address Groups.

A. Is there a message address group called TOC? Yes No

B. Is the addressee cdr-bde1-3id? Yes No

C. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-2; one point for each Yes; ignore comments.

Task 7. Set the free text message default address

Select Create tab. Highlight 'free text message". Select Message Addressing.

A. Is the addressee cdr-bde1-3id? Yes No

Select the Message Setting Tab to the left.

B. Is the precedence set to *immediate*? Yes No

C. Is the acknowledgement set to *operator acknowledge*? Yes No

D. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-3; one point for each Yes; ignore comments.

Task 8. Create and Send a Free text message

Select Sent Queue tab. Highlight the free text message. Select Execute.

A. Was the free text message sent? Yes No

B. Is the addressee the Bde Cdr? Yes No

C. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-2; one point for each Yes; one point if 8b is No *and* address matches the TOC address created in Task 6.

Task 9. Create, save, and send a SPOT report.

Select the Edit tab. Expand unitmessages and select SPOT1. Click Execute. Select the Preview Tab. Scroll down to view message.

A. Was there a message named SPOT1 in unitmessages? Yes No<u>**See Note</u>

B. Did the message indicate 3 rotary wing aircraft? Yes No

C. Did the message indicate the entity location 14RPV1652 5053? Yes No

D. Did the message indicate they were hostile? Yes No

E. Did the message indicate they were reconnoitering? Yes No

F. Did the message indicate there were 6 AT missiles? Yes No

G. Did the message indicate they were moving at medium speed? Yes No

H. Did the message indicate they were moving to the southeast? Yes No

Select the Message Options button on the lower left corner of the screen.

Select the Message Settings tab

I. Was the precedence set to *immediate*? Yes No

J. Check the Sent Queue – did it indicate that SPOT1 was sent? Yes No

Select the Addressee tab.

K. Is the addressee cdr-bde3-3id? Yes No

****<u>Note</u>: If it is not in unitmessages, is it in combatmessages? Yes No**

If it is in combatmessages, is it named Spot1? Yes No

L. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-12; one point if any Spot report is found in "unitmessages" folder or in "combat messages" folder; one point if report name is "SPOT1"; one point for each Yes in 9b thru 9k. [*This item has two more points possible than the same item in the initial test.*]

Task 10. Display and save a message.

Select the Manage tab. Expand unitmessages.

A. Is there a message saved that is named MOVE1? Yes No

B. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-1; one point if 10a is Yes; one point if 10a is No *and* report name is a variation of MOVE4.

NOTE – Close F4 Messages when this task is completed.

Task 11. Create a Route with 5 waypoints.

Select NAV. Select the down arrow and locate ROUTEPUMA. Select it.

A. Is the route displayed on the map? Yes No

B. Is the route name ROUTEPUMA? Yes No

C. Indicate the number of waypoints in the route

______

D. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-3; one point if 11a is Yes; one point if 11b is Yes; one point if 11c is 5.

Task 12. Center Icon on Map

A. Is the blue filled icon in the center of the map sheet? Yes No

B. Is the AutoCenter off? Yes No

C. Comments: (if any items are "NO" copy student's response below)

Range of Scores: 0-1; one point if 12a is Yes; exclude 12b from scoring.

NOTE-1: Ignore errors (especially spelling and transposition) in students' handwritten responses.

NOTE-2: If a clear answer cannot be determined for an item, treat it as a missing data point.

APPENDIX D

STATISTICAL TABLES FOR ITEM ANALYSES

Table D1

Chi-Square (McNemar) Results for Knowledge Test Questions

	Question	Improve	Decline	χ^2	p	
5	Packet mode message size limit?	2	26	20.57	0.000	*
3	The two system screens are?	1	7	4.50	0.070	
2	FIPR stands for what?	3	7	1.60	0.344	
10	Time zone to enter reminders?	7	9	0.25	0.804	
9	Advantage of FBCB2-T & BFT?	0	0	0.00	n.s.	
4	Four main areas of Ops screen?	0	0	0.00	n.s.	
8	How to speed up a slow system?	9	4	1.92	0.267	
7	LOS tool determines what?	15	5	5.00	0.041	*
1	FBCB2 stands for what?	14	3	7.12	0.013	*

Note. The "Improve" column gives the number of individuals whose scores improved across the two tests and the "Decline" column lists the number whose scores declined across the two tests.
* $p \leq .05$.

Table D2

Chi-Square (McNemar) Results for Knowledge Test Components

	Question / Component	Improve	Decline	χ^2	p	
3	Name the two screens on FBCB2.					
	Session manager	2	7	2.78	0.180	
	Operations	7	14	2.33	0.189	
2	What does FIPR stand for?					
	Flash	3	7	1.60	0.344	
	Immediate	3	5	0.50	0.727	
	Priority	5	6	0.09	1.000	
	Routine	4	5	0.11	1.000	
9	List one advantage to FBCB2 and BFT					
	FBCB2	0	0	0.00	n.s.	
	BFT	2	3	0.20	1.000	
4	What are the four main areas of the Ops screen?					
	Classification banner	0	7	7.00	0.016	*
	Map display	10	6	1.00	0.454	
	Operations function bar	2	10	5.33	0.039	*
	Communications/FIPR queue	2	4	0.67	0.688	
7	The LOS tool allows the Soldier to determine?					
	Bearing	14	5	4.26	0.064	
	Range	14	6	3.20	0.115	
1	What does FBCB2 stand for?					
	Force 21	13	2	8.07	0.007	*
	Battle	11	5	2.25	0.21	
	Command	10	5	1.67	0.302	
	Brigade and	12	2	7.14	0.013	*
	Below	12	2	7.14	0.013	*

Note, Questions 5, 8, and 10 are all single component questions so their McNemar results are not repeated from Table D1. * $p \leq .05$.

Table D3

Chi-Square (McNemar) Results for Hands-On Test Task Scores

	Task	Improve	Decline	χ^2	p	
12	Auto center icon on map	3	16	8.89	0.004	*
11	Create route on map	5	16	5.76	0.027	*
6	Create address group	2	12	7.14	0.013	*
2	Clear logs and queues	5	13	3.56	0.096	
3	Position icon on map	4	11	3.27	0.118	
7	Set free text defaults	5	12	2.88	0.143	
10	Save incoming message	4	11	3.27	0.118	
4	Adjust SA settings	4	10	2.57	0.180	
5	Create message folders	0	5	5.00	0.063	
1	Verify platform role	2	3	0.20	1.000	
8	Create/send free text message	5	5	0.00	1.000	
9	Create/send SPOT report	8	7	0.07	1.000	
13	Check line of sight	12	10	0.18	0.832	

Note: The "Improve" column gives the number of individuals whose scores improved across the two tests and the "Decline" column lists the number whose scores declined across the two tests.
* $p \leq .05$.

Table D4

Chi-Square (McNemar) Results for Hands-on Test Component Scores

	Task / Component	Improve	Decline	χ^2	p	
11	Create route on map					
	Route displayed on screen	3	20	12.57	0.000	*
	Route named correctly	4	9	1.92	0.267	
	Route has correct number of waypoints	6	10	1.00	0.454	
6	Create address group					
	Address group named	2	7	2.78	0.180	
	Address group addressee correct	2	12	7.14	0.013	*
2	Clear logs and queues					
	One message in FIPR queue	7	9	0.25	0.804	
	No old messages	7	6	0.08	1.000	
	No other directories	15	9	1.50	0.307	
3	Position icon on map					
	Icon on Map	0	15	15.00	0.000	*
	Icon Location correct	4	11	3.27	0.118	
7	Set free text defaults					
	Set free text message default address	4	15	6.37	0.019	*
	Set free text message default precedence	7	8	0.07	1.000	
	Set free text message default acknowledge	7	9	0.25	0.804	
4	Adjust SA settings					
	SA: stale setting correct	4	9	1.92	0.267	
	SA: old setting correct	4	7	0.82	0.549	
	SA: purge setting correct	4	8	1.33	0.388	
5	Create message folders					
	Directory 1 named	0	3	3.00	0.250	
	Directory 2 named	0	5	5.00	0.063	
8	Create/send free text message					
	Free text message sent	3	4	0.14	1.000	
	Free text message address correct	5	5	0.00	1.000	
9	Create/send SPOT report					
	SPOT report in folder	8	4	1.33	0.388	
	SPOT report named correctly	6	9	0.60	0.607	
	SPOT: vehicle1 indicated	10	9	0.05	1.000	
	SPOT: entity 1 location indicated	13	3	6.25	0.021	*
	SPOT: entity 1 status indicated	8	5	0.69	0.581	
	SPOT: entity 1 activity indicated	8	8	0.00	1.000	
	SPOT: entity 2 indicated	7	7	0.00	1.000	
	SPOT: precedence indicated	7	11	0.89	0.481	
	SPOT: report sent	6	13	2.58	0.167	
	SPOT: address correct	15	10	1.00	0.424	
13	Check line of sight					
	LOS is displayed	12	11	0.04	1.000	
	LOS height correct	10	7	0.53	0.629	

Note: Tasks 1, 10, and 12 had only one component so their McNemar results are not repeated from Table D3.

* $p \leq .05$.

Table D5

Paired t-Test Results (Two-Tailed) for Performance Times in Hands-on Tasks

Task	Baseline Mean (min)	Recall Mean (min)	*t*	*df*	*p*	
3. Position icon on map	1.55	3.02	4.13	47	<.001	**
2. Clear logs and queues [a]	3.77	5.07	3.53	46	<.001	**
6. Create address group	1.83	2.57	3.42	40	.001	**
4. Adjust SA settings	0.85	1.48	5.12	52	<.001	**
9. Create/send SPOT report [b]	3.63	4.17	1.77	46	.083	
5. Create message folders	1.17	1.68	2.85	52	.006	**
12. Center icon on map	0.11	0.41	3.82	44	<.001	**
10. Save incoming message	0.67	0.87	3.18	46	.003	**
7. Set free text defaults	1.20	1.38	1.47	46	.147	
1. Verify platform role	0.47	0.63	2.51	52	.015	*
8. Create/send free text message	1.52	1.67	1.16	48	.250	
11. Create route on map	2.90	2.63	0.78	45	.439	
13. Check line of sight	1.90	1.33	2.93	48	.005	**

[a] Clearing logs and queues included time for the FBCB2 workstation to reboot. [b] The recall version of this task included two more steps than the baseline version.

* $p < .05$, ** $p < .01$.

Table D6

Means and Standard Errors of Performance on the Hands-on and Knowledge Tests by Self-Rated Proficiency

Test	Never Use	Basic	Medium
	Knowledge Test Question Score		
Baseline	24% (±3%)	41% (±3%)	45% (±3%)
Recall	30% (±5%)	38% (±2%)	42% (±3%)
	Knowledge Test Component Score		
Baseline	26% (±6%)	46% (±4%)	54% (±3%)
Recall	34% (±7%)	46% (±3%)	52% (±3%)
	Hands-on Test Task Score		
Baseline	60% (±6%)	71% (±3%)	76% (±3%)
Recall	38% (±9%)	64% (±4%)	64% (±5%)
	Hands-on Test Component Score		
Baseline	72% (±6%)	78% (±3%)	81% (±3%)
Recall	46% (±11%)	75% (±4%)	78% (±3%)

APPENDIX E

STEPS FOR COMPLETING HANDS-ON TASKS

1. Task: Identify Platform Role Configuration

Steps:

1. While in the Session Manager screen, note the platform role as listed in the bottom pane of the function bar, located on the lower right hand side of the screen.
2. Write the platform role on the answer sheet.

Note: This task does not involve any manipulation of the user interface.

2. Task: Clear Logs and Queues

Steps:

1. While in the Session Manager Screen and offline, select 'Start' on the task bar. Select 'FBCB2' from the menu, and 'Clear Logs and Queues' from the FBCB2 sub-menu.
2. Select items to be cleared by checking the radio button next to the desired item (note: the 'reset' radio button, located at the bottom of the dialogue box, clears all fields).
3. Select 'Apply' to clear selected item(s).
4. Select 'Close' button when message "COMPLETED CLEAR LOGS & QUEUES OPERATION" is displayed.
5. Select 'Close' in Clear Logs and Queues dialog box.

3. Task: Position your Icon

Steps:

1. From the Operations Main Screen, select "F6 Admin" from the function bar on the right side of the screen.
2. If not already there, go to the 'Platform' tab, and select the 'Location' sub-tab (this is the default).
3. At the Location text field, select the dropdown arrow. Select 'KBD' from the dropdown list and type in the location grid coordinates, or select 'Map' to click on a location on the map.
4. Select 'Apply'
5. Select 'Close'

4. Task: Set SA Currency

Steps:

1. From the Operations Main Screen, select 'F6 Admin'
2. Select the 'SA' tab
3. Using the 'Friendly,' 'Observed,' and 'Air' sub-tabs, set the currency thresholds for each type of SA.
4. In each sub-tab, set the 'Stale' time threshold by selecting the dropdown next to the defaulted time. Highlight the desired length of time for SA to remain fresh.

5. Set the 'Old' time threshold by selecting the proper length of time for icons to remain stale, from that dropdown.

6. Set the 'Purge' time threshold by selecting the time period from the 'Purge' dropdown, indicating when the SA will be terminated.

7. Select 'Apply'.

8. Select 'Close'.

5. Task: Create Two Messages Folders

Steps:

1. While in the Main Operations Screen, select the 'F4 Messages' button from the function bar on the right side of the screen
2. Select the 'Manage' tab
3. Type a folder name in 'Name' field found on the lower right of the manage tab.
4. Select the 'New Folder' button on the left side of the tab.
5. Delete the name displayed in the "Name" text field, and enter the name of the second folder.
6. Select the 'New Folder' button to create the second folder.
7. Select 'Close'.

Note: steps 5 and 6 are a repetition of steps 3 and 4.

6. Task: Create Address Groups

Steps:

1. Select the 'F4 Messages' button
2. Select the 'Create' tab (which is the default)
3. Select the 'Edit Address Groups' button
4. On the lower, right side of the tab, Enter the Address Group name in the Name text field
5. Select the 'New Group button' which is located in the center of the 2 panes.
6. Above the left pane, use the "Select From" dropdown to select the appropriate address group.
7. Search for address in the database by typing an address name in the "Search" field, at the bottom of the left pane, and select 'Search'.
8. From the right pane, highlight the Address Group where the address will be stored.
9. Select 'Add Address', located between the two panes, to add the address to the newly created Address Group.
10. Select 'Apply' to accept the change, but keep working in the "Edit Address Groups" dialogue box. OR Select 'OK' to apply the change and close the dialogue box.

7. Task: Create Default Options and Address for Free Text Messages

Steps:

1. Select 'F4 Messages' button from the function bar of the Operations Main Screen.
2. Select the 'Create' tab.
3. Select one of the Msg Type option buttons, in the upper left corner of the tab, to find the appropriate message.
4. Highlight "freetext message" from the list in the center pane of the tab.
5. Select the 'Set Default Message Addressing' button to access the "Message Addressing" dialogue box.
6. From the two tabs in the dialogue box, select the left, or "Message Settings" tab.
7. From the Message Settings tab select the Precedence option by clicking on the appropriate radio button.
8. Select one or more Acknowledge check boxes.
9. Select the 'Apply' button prior to changing tabs to ensure changes.
10. Select "Addresses" tab
11. Using the "Select From" dropdown, highlight the appropriate address book.
12. Select desired Platform Roles from left pane displaying the chosen address book
13. Select 'Add' button between the panes
14. Select 'Apply'
15. Select 'Close'

8. Task: Create and Send a Free Text Message

Steps:

1. While in the Ops main screen, select the 'F4 Messages' button from the Function Bar on the right side of the screen.
2. Select the 'Create' tab.
3. Highlight "Free Text Message" from the list of messages in the center pane of the tab.
4. Select the 'Execute' button.
5. Highlight the 'Subject' text field and enter subject.
6. Highlight the main text box and type the message.
7. If not defaulted, select the 'Message Option' button at the bottom of the message.
8. In the Message Addressing dialogue box, select the "Message Settings" tab.
9. Select desired Precedence and Acknowledgement of the message.
10. Select the 'Apply' button to accept the change.
11. Select the 'Address' tab.
12. From the appropriate address book, select desired addressee, searching if necessary.
13. Select 'Add' to add the address to the message. Repeat steps 11 & 12 as needed.
14. Select 'OK' to apply to changes and close the dialogue box.
15. If the message is to be saved, select 'Save As' and provide a file name and folder destination.
16. From the message, select the 'Send' button.
17. If an "Address Availability" reminder appears to advise that some receiving platforms are not on the net, select 'Send' again.

NOTE: On both the baseline and retention tests, participants were instructed to alter the precedence setting from the default established in Task 7. They did not have to change the Acknowledgement setting. The addressee is in the TOC address group so there was no need for them to search the address book.

---

9. Task: Create, Save, and Send a SPOT Report

Steps:

1. Select the 'F3 Combat Msgs' button from the function bar, on the right side of the Ops Main Screen (defaults to the SPOT Report)
2. Under the 'SPOT' tab select the Equipment type from the drop-down menu of the top, right text field. If more than one type of equipment is to be reported, utilize the 'Equipment 2' text field, directly below.
3. Select the dropdown button next to the "Location" text field. Select 'KBD' to type the grid coordinate in the text field, or use 'Map' to select a location from the map.
4. Fill the DTG field using the keypad (defaults to NOW)
5. In the first field on the right side, select the Observed Affiliation from drop down box (defaults to "hostile")
6. Select the Activity from the drop-down menu (Defaults to "stationary")
7. Select the 'Save' button at the bottom of the SPOT report, to save the report to the Combat Messages folder in F4 Messages.
8. If Default Message Addressing was not done prior to executing Combat Messages, select 'Long-Form' message button at the bottom of the report.
9. Select the 'Message Options' button
10. Select the 'Message Settings' tab
11. Select the desired precedence
12. Select the desired Acknowledgement
13. Select the 'Addresses' tab
14. Select desired unit from the left hand panel
15. Select 'Add'
16. Select 'OK'
17. Select 'Save As'
18. Type the filename for the message in the appropriate space
19. Select the folder the message is to be saved in. NOTE: COMBAT MESSAGES WILL NOT BE IN THE COMBAT MESSAGES USER FOLDER.
20. Select the 'OK'
21. Select the 'Send' button
22. Select the 'Send' button again

NOTE: Some participants chose the Save button from the short form and saved the message in the Combat Messages folder. MAKE SURE THE MESSAGE ADDRESSING IS DEFAULTED PRIOR TO EXECUTING. FAILURE TO DO SO DEFEATS THE PURPOSE OF THE 11-SECOND EXECUTION RULE FOR COMBAT MESSAGES. TAKE CARE NOT TO DELETE ADDRESSES ALREADY DEFAULTED BY FBCB2. THESE ABCS THREADS MUST REMAIN TO ENSURE AN ACCURATE COP.

10. Task: Display and Save a Message

Steps:

1. From the OPS Main Screen, Select appropriate FIPR counter on the FIPR Queue located in the status bar at the top of the screen
2. From the open tab, select and highlight message received
3. Select the 'Display' button at the bottom of the tab
4. Select 'Save As'
5. From the 'Save As' dialogue box, select the appropriate folder, and assign the message a file name
6. Select 'OK' then 'OK' to acknowledge the 'Message Saved' banner.
7. Select 'Close' at the bottom of the message

11. Create a Route with Five Waypoints.

Steps:

1. Select the 'NAV' button from the Function Bar of the Ops Main Screen.
2. From the "Route" tab select 'Create'
3. From the "Create Nav Route" dialogue box, in the "Enter waypoints field", select 'Map'
4. Enter the waypoints by clicking on the map along the route, or by highlighting the "Location" text field and typing in the appropriate grid coordinates.
5. Select 'OK' to exit the "Create Route" dialogue box and return to the Navigation dialogue box.
6. Check the 'Drivers Display ON' radio button, then 'Steer To' button at the bottom of the Navigation tool. The drivers display will appear by which you can maintain course while navigating the route.
7. If navigation tool is not to be used but the route must be displayed, select 'Close' from the Drivers Display.

NOTE: Any time a route is accessed, 'Drivers Display On', 'Steer To', and 'Close' must be executed to keep the route displayed after the Nav box is closed.

12. Task: Auto Center Your Icon

Steps

1. Select the auto-center button at the top right corner of the function bar in the Ops Main Screen. The map will center on platform icon.
2. Turn the auto-center off by selecting the button a second time.

NOTE: Turning the auto-center off was not a requirement of the test but some may have been taught to turn it off in a moving vehicle to avoid locking up the system.

13. Task: Create a LOS between Two Points and Display

Steps:

1. Select the 'LOS' button from the Function Bar in the Ops Main Screen
2. Select the two points on the map
3. Select 'OK'
4. In the "Dist. Above Ground (m)" field, enter the appropriate value
5. Select 'Profile Show'

DEMONSTRATION TASK: Using Circular LOS Tool

Steps:

1. Select 'F7 Apps' button from the Function Bar of the Ops Main Screen
2. Highlight 'Circular Line-of-Sight'
3. Select 'Execute' button
4. Enter location by using the dropdown next to the text field and choosing 'KBD' to type coordinate, 'Map' to select a location on the map, or 'Own' to use platform location as center of CLOS.
5. In the "Dist. Above Ground (m)" field enter the distance above ground for CLOS
6. Enter Fan Range
7. Select 'Execute' and FBCB2 will draw the CLOS
8. Select 'Close' to turn Circular LOS "OFF"